Identifying the Factors that Affect Mistrust and Uncertainty in Front-End Performance of Korean MNEs

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List of Abbreviations

NPD	New Product Development
MNEs	Multinational Enterprises
FEI	Front End Innovation
ES	Early Stage
DII	Data, Information and Insights
OL	Organisational Learning
KM	Knowledge Management

Abstract

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This study investigates and identifies the factors that affect mistrust and uncertainty when Korean industrial multinational enterprises (MNEs) generate new ideas in the front-end phase of new product development (NPD) processes. Specifically, this study focuses on the process of applying research data to support the generation and development of new products. Current research indicates that many companies frequently experience difficulties in this regard.

This study comprises a large body of empirical study-centred research. It collates multiple interviews with research-based teams (consisting of planners as well as marketers and lifestyle researchers) and practice-based teams (i.e. designers and engineers) of leading multinational companies in the smart electronics and automobile industries.

A primary outcome of the research is the specification of key constructs relating to mistrust and uncertainty during the application of research data in the process of selecting new ideas within the front-end of the NPD process, which appear to be linked to three factors: (i) a lack of common language (perspectives and approaches related to data and information when obtaining insights) between diverse expertise groups, (ii) a lack of appropriate communication channels between different functional groups, and (iii) a lack of productive tactics in using internal information.

This research aims to enrich NPD studies by presenting the validity of the existing theory with detailed practical examples and to find distinctive new knowledge by identifying emerging issues from recent NPD processes in the industry.

Furthermore, this study establishes an idea generation framework that will potentially enable MNEs to use their research data more effectively when developing real products and to better perform cross-functional tasks.

Keywords: MNEs, NPD, Front-end, Idea Generation, Design thinking, Multidisciplinary, Mistrust, Uncertainty, Stimulus Data

1. Introduction

The goal of this research is to contribute to current knowledge about new product development (NPD) and the conversion of high-quality ideas into innovative new products. This study focuses on industrial multinational enterprise (MNEs) samples, in order to determine the factors that impact on how MNEs apply and utilise their current research data and information in the front-end innovation (FEI) development of their new products. To introduce the focal point of the research and its related context, this chapter comprises the following themes:

- Background and Motivation
- Context
- Overview of South Korean Industry and Business
- Key Authors
- Identified Gap and Contribution
- Focus of Study
- Review of Relevant Literature and Theory
- Research Questions
- Data Collection and Analysis
- Findings
- Discussion
- Conclusions
- Research Structure

Background and Motivation

The following question was triggered by personal work experience in a multinational automobile company in Korea: How can internal conflicts between different types of teams be reduced in NPD processes so that a company can better generate innovative ideas?

My main role at the company's design centre was to analyse markets, design trends, consumer needs, and competitive products, and to improve the perceived quality of new products based on the analysis results. Therefore, from the beginning until the launch of any NPD project, a key activity of my role was collaboration with the planning team (which included planners, marketers and lifestyle researchers), the design and engineering teams, and sometimes with suppliers. In this position, dealing with the internal conflicts caused by each team's different perspectives and manner of operating projects was the most challenging task in the collaboration – and it affected the level of efficiency and the outcomes of NPD. Specifically, I was partly involved in both research and actualising real products activities at the design centre; thus, I sensed that the conflicts were particularly intense between the research-centred organisations (planning team) and practice-centred organisations (design and engineering teams). In addition, I realised that this is a crucial challenge that the company must address in order to achieve efficient NPD and innovative outcomes.

Many Korean MNEs have adopted the Western (especially US) NPD process, and my previous company also had a complex environment where US business processes and a Korean corporate management culture coexisted. For this reason, I believe it is important to conduct an in-depth investigation into issues of internal conflicts emerging from environments where globally general NPD processes and typical Korean business culture mix.

I decided to carry out my PhD research in the UK to broaden my knowledge range and build my knowledge system for idea management in a new environment, away from the familiarity of US or Korean business processes. It is because I believe that the research results drawn from the synthesis of theoretical knowledge and practical principles that is explored from different academic and business environments can provide an objective and meaningful direction for the NPD processes of MNEs.

Therefore, my research proceeds in the following three steps: 1) theoretical analysis related to idea management of NPD, 2) understanding issues emerging from actual NPD practices, and 3) comparing issues between theoretical and empirical studies to capture opportunities for improving idea management activities and outcomes of MNEs.

Context

Historically, innovation and enterprise research has emphasised the importance of idea generation activities in NPD to cope with changing consumer needs and unexpected market change (Cross, 2001; Hatchuel et al., 2010; Negroponte, 2003; Pink, 2006). The idea generation and development stage is known as the early part of the NPD process, from the point of first consideration of new opportunities to the point that identifies ideas ready to be actualised (Cooper, 1990; Kim &

Wilemon, 2007; Murphy & Kumar, 1997). It is commonly called the front-end phase (Dahan & Hauser, 2001; Toubia, 2006).

By analysing studies on the topic, researchers have found that idea generation and development activities in the front-end phase may have a significant impact on the success or failure of the final outcomes of NPD (e.g. Argument et al., 1998; Bhamra, 2004; Poole & Simon, 1997). This factor also relates to today's rapidly changing market and business environments. These changes make predicting the future results of companies' business and NPD activities uncertain (Cross, 2001; Hatchuel et al., 2010).

Therefore, to increase the probability of success in future NPD outcomes, companies need to reduce the level of uncertainty in the initial phase of idea generation, so that the results from the front-end stage can be effectively applied to actual development (Kijkuit et al., 2007). In actual NPD processes, however, companies have found it challenging for a project to be conducted through a systematic linkage between research results and practical works (Buchanan, 2001; Gregor et al., 2007; Hubbard, 2010; Pugh, 1991). The findings of many idea management studies demonstrated that companies often face difficulties in applying research results to actual projects, and they struggle to find strategic ways to transition between them effectively (Buchanan, 2001; Fraser, 2009). In other words, companies recognise the importance of the need for linking research and practice activities to achieve successful NPD. However, they are trying to improve their idea generation process without fully understanding what, where and why the problems are emerging (see Section 4.4).

For this reason, this study focuses on the nature of the idea generation and development process in order to discover the factors that cause uncertainty and mistrust when applying research results to practical works in NPD.

Overview of South Korean Industry and Business

To investigate NPD and idea generation issues emerging from environments which mix globally-used NPD processes and local business culture, this study focused on industrial companies that were influenced by South Korean management culture. Many international economists note that South Korea has one of the world's fastest-growing economies (Almansoori, 2014; Amsden,1993; Ritz & Bevins, 2012). According to them, this rapid growth emerged in the late 1970s as a response to a 20-year period of turmoil following independence from Japan in the 1940s and civil war in the 1950s.

Korea was a Japanese colony (1910-1945), and most of its infrastructure and base facilities were built for providing logistical support during the Second World War (Heo, 2005) such as roads, railways, electrical power generation, buildings and harbours, which had been destroyed during the Korean War (1950-1953) (Matles & Shaw, 1990). This led to South Korea remaining one of the world's poorest countries until the 1960s. In this decade, especially the earlier part, South Koreans suffered from poor access to, and inefficient creation of, goods and services while an industrial base and infrastructure was being established (Amsden,1993; Verganti, 2009).

During the initial 20 years of industrialisation (the 1960s and 1970s), South Korea faced the same problems as other developing countries in terms of continued instability of external market surroundings, and sustained trade deficits (Lee, 2013). The trend towards self-protectionism in the face of dangers of damage from global stagflation, a result of the first oil crisis, spread quickly across the world. In addition, South Korea's labour-intensive light industry, which had initially competed with other developing countries, became less competitive, due to a rapid increase in wages (Koojaroenprasit, 2012).

Also, as South Korea had a relative shortage of natural resources compared to other developing countries, the South Korean government had to revise its economic goals strategically throughout the 1970s; instead of labour-intensive light industry, the government placed emphasis on promoting heavy industries such as shipbuilding, steel, automobiles, machinery, and petrochemicals in order to induce industrial restructuring (The Korean Economy, 2010). The South Korean government also began to focus on the development of technology and human talent by establishing public funds and public research and development (R&D) institutes related to manufacturing businesses and heavy and chemical industries. At that time, research results from public organisations were shared with private companies, and additional R&D activities run by private companies were encouraged by the government with a tax benefit (Gupta et al., 2013; Lee, 2013).

In the 1980s, multiple joint R&D efforts for larger and more challenging projects were undertaken between the government and private firms. The strengthening of R&D and the interest in higher education in the 1980s became the foundation of knowledge-centred growth in South Korean industry today (Gupta et al., 2013; Lee, 2013).

Through this state-led R&D, and the government's support for education and private corporations, the South Korean economy has grown rapidly since the

1990s based on the successful development of science and technology capabilities. South Korea joined the OECD in 1996 and held the G20 Summit in 2010 (Gupta et al., 2013; Koojaroenprasit, 2012; The Korean Economy, 2010).

> *The Gross Domestic Product (GDP) in South Korea was worth 1530.75 billion US dollars in 2017 (ranked 11th worldwide by International Monetary Fund). The GDP value of South Korea represents 2.47 percent of the world economy. GDP in South Korea averaged 423 USD Billion from 1960 until 2017, reaching an all time high of 1530.75 USD Billion in 2017 and a record low of 2.42 USD Billion in 1961 (Tradingeconomics, 2017, para. 1).*

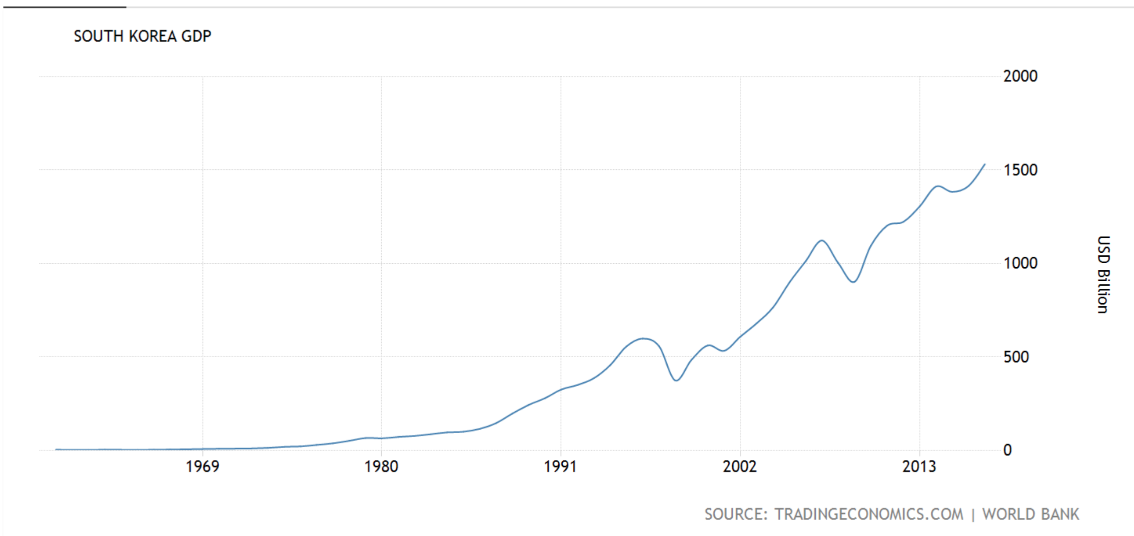


Figure 1. South Korea GDP from 1960 to 2017 (Tradingeconomics, 2017)

While South Korea was embarking on developing a manufacturing industry, it adopted mixed methods from the Japanese low-cost manufacturing process (notably, product quality and manufacturing process centred systems) and Western supply chain models. Furthermore, it continuously invested in R&D and human talent development (Chung 2011; Gupta et al, 2013). As a result, Korea has been recognised as one of the most advanced countries since the 2000s (Almansoori, 2014; Choi, 2012; Ritz & Bevins, 2012).

In the past 20 years, the rapid growth of Korean product companies in the global marketplace has been remarkable. According to Interbrand's reports of the best global brands[1], internationally acknowledged as high-value research and also ISO[2] certified, the rankings of some Korean product companies such as Samsung, Hyundai, and Kia have increased; at the same time, those of non-Korean global industrial companies such as Honda, Ford, Sony, and Nokia, regarded as the leaders in the industrial field in the 1990s, have decreased or remained at a standstill (Interbrand, 2018, see Figure 2).

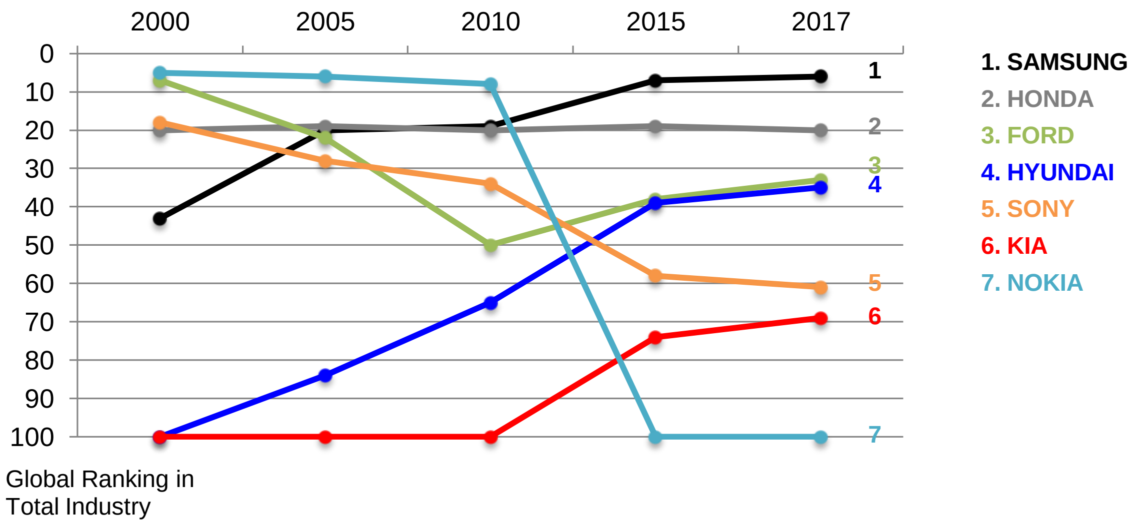


Figure 2. The Change in Ranking in 'Best Brand top 100' from 2000 to 2017 (Interbrand, 2018)

The South Korean business and industry has been closely linked to that of the United States (US) over most areas of government, state institutions and private companies. For example, more than 50% of Korean faculties have received higher education in the US, and several collaborative research organisations such as the Korea-U.S. Science Cooperation Center (KUSCO) are in operation. It also

[1] Criteria for Inclusion in Best Global Brands: 1) At least 30 percent of revenue must come from outside of the brand's home region. 2) The brand must have a significant presence in Asia, Europe, and North America as well as broad geographic coverage in emerging markets. 3) There must be sufficient publicly available data on the brand's financial performance 4) Economic profit must be expected to be positive over the longer term, delivering a return above the brand's cost of capital. 5) The brand must have a public profile and awareness across the major economies of the world (Interbrand, n.d., para. 4).

[2] The International Organization for Standardization (ISO) is an international standard-setting body composed of representatives from various national standards organizations (Wikideia, n.d., para. 1).

cooperates with the US to establish multiple types of start-up businesses (Gupta et al., 2013).

Also, the Korean corporate culture has a strictly vertical hierarchy, influenced by custom from traditional Confucian ideals of respecting the elderly, as well as by mandatory military service (Cho & Yoon, 2001; Kim & Tung, 2013; Lee, 2001; Rowley, 2013). The advantage of the hierarchical corporate culture is that it can maximise the effectiveness of product development, production, and cost reductions under a relatively stable organisational environment, often eliminating redundant processes and avoiding time-wasting (Cameron & Quinn, 2011; Linnenlueck & Griffiths, 2010). However, hierarchical corporate culture can result in high levels of tension and dissatisfaction among employees when managers with administrative power but little practical experience supervise working environments, as authority is conferred on the basis of political position rather than to experts in more applied fields (Naser, Shobaki, & Amuna, 2016).

This study confirmed that Korean MNEs generally operate planning (Research-centred), design (Practice-centred), and engineering (Practice-centred) teams as their main three divisions. This reflects the prevailing paradigm of the knowledge-centred modern era, in which multidisciplinary thinking is required to respond to consumer needs for emotional fulfillment and rapid implementation of new technology (Holloway, 2009; Negroponte, 2003; Verganti, 2003). However, the hierarchical Korean company culture, often referred to as 'top-down direction' (where product concepts are decided by the results of a planning team's activities), contradicts the purpose of establishing a tripartite organisational structure, causing conflicts to emerge amongst various departments. Also, in the findings of this research, it was revealed as an obstacle to the design and engineering teams' chances of contributing to multidisciplinary thinking in the idea generation phase (see Figures 18–23 on p. 193–198, and Figure 25 on p. 234).

In summary, the typical characteristics of Korean traditional business for the last four decades are government-led enterprise, concentration on R&D and technology, focus on large product companies, close relationships with the American business community, and a hierarchical corporate culture.

Recently, however, while a number of MNEs in South Korea have emerged as leading companies in the global markets, various changes have been seen in the existing typical business models of South Korea. Most of South Korea's MNEs have had a close relationship with the government as they grew with the government's full support since the 1970s. Now, on the contrary, these large private companies are supporting the government. The most innovative R&D is being undertaken by companies themselves using their own budget, and they are actively involved in the development of technology and human talent, often investing in government-planned research complexes or by partnering with universities (Gupta et al., 2013; Lee, 2013). However, due to the historically close relationship between the government and MNEs, the Korean economy tends to focus disproportionally on the performance of MNEs, rather than that of SMEs (Kwon, 2014).

In addition, to respond to recent market demands for innovation, South Korean government agencies and companies have invested not only in manufacturing science and technology, but also in innovative business systems and methodologies interconnected with basic science and technology (Gupta et al., 2013; Stone et al., 2008). Also, since most Korean MNEs are currently targeting global consumers, they are absorbing global sourcing of knowledge and ideas from many parts of the world, not just from the US (Khanna et al., 2011).

In circumstances in which companies have to cope with fast-changing market environments and consumer needs, Korean industrial companies have achieved rapid growth for the last four decades, and have specifically showed high performance in outputs and global markets in the last ten years. Hence, this study aims to explore recent NPD processes of MNEs operating within Korean business cultures, so that the opportunities identified can contribute to (a) any global industrial firms that pursue rapid growth, and (b) the broader success of NPD in the fast-changing global market environment.

Key Authors

This research encompasses a large body of empirical study-centred research. It uses the NPD models of Cooper (1990) and Ulrich and Eppinger (1995), whose key concepts of empirical study have had a direct impact on many NPD and front-end studies (Ekerå et al., 2015; Trott, 2012). Cooper's NPD model (1990) introduces the fundamental NPD activities of companies in a sequential and systematic way (see p. 37), which provides a basic framework for systematically exploring the issues arising at each stage and the correlations between the stages of the NPD process. Also, Ulrich and Eppinger' study (1995) shows a sub-activity model deepened by each main stage, with suggestions for the roles of each

functional team accordingly (see p. 38). Their work helps this thesis to obtain in-depth, accurate information on each functional team's actual activities and on the conflict points between different expertise groups when generating ideas.
Hence, this study expects that the mixed use of the Cooper and Ulrich and Eppinger models will enable the research on idea generation and NPD to explore valuable and distinct issues through integrating both macroscopic and microscopic viewpoints on the NPD process (Ekerå et al., 2015).

Identified Gap and Contribution

The early studies on the idea generation process in NPD were generally comprehensive and theory-centred. For the last few decades, however, many recent studies have gone beyond theoretical study to explore practically applicable methods of idea generation for an organisation's NPD processes (Ekerå et al., 2015; Griffin & Hauser; 1996, Song et al., 1998; Trott, 2012). Despite these studies, companies are constantly adjusting and testing their idea generation processes to deal with unexpected market changes and consumer needs (Fraser, 2009; Hatchuel et al., 2010; Pink, 2006). For this reason, idea generation study needs to continue exploring the practical methods that companies can actually adopt, so that they will have a guide to maintaining successful and innovative businesses in a rapidly changing market environment.
Furthermore, modern companies are aware of the significance of cross-functional tasks in the front-end phase of NPD, which are necessary for meeting the uncertain and unpredictable market needs of a society that possesses an abundance of knowledge and goods (Negroponte, 2003; Pink, 2006). In this regard, the integration of ideas from different expertise groups and the reduction of conflicts between them have become one of the core issues for many companies to solve.
Therefore, this research addresses the following goals so that companies will be able to better apply their ideas to actual product development efficiently, through new ideas established by the effective integration of various knowledge from multiple expertise groups: (1) to explore theoretical issues related to the idea generation and cross-functional tasks in the front end of NPD; (2) to examine the idea generation processes and cross-functional tasks of the sample companies leading the market in the last decade, and specifically to compare activities between different functional teams in each front-end step; (3) to identify issues that arise at each step, and to investigate correlations between the issues identified; (4)

to discover conformance and contradiction between the findings from the theoretical study (1) and the empirical studies (2 and 3) to identify the opportunities that can contribute to improving the front-end performance of NPD. Academically and in practice, this study can provide uniqueness in terms of the following four areas: (1) An improved model for multidisciplinary or cross-functional idea generation and development activities; (2) A new interpretation of the relationship between multidisciplinary approaches and NPD processes; (3) Provision of actionable recommendations and guidance for application in Korean MNEs; and (4) Presentation of detailed, high quality cases that strengthen and enrich current academic knowledge in relation to NPD (see Section 6.1).

Focus of Study

This study has conducted in-depth research on the following topics.

- Activities related to front-end phase of the NPD process
- The nature of recent front-end processes of MNEs that are leading the industrial market
- Different front-end perspectives between various expertise groups and their related activities
- Factors impacting on the effectiveness of applying research data and results to the development of new products.

This study focuses on the front-end stage of the NPD process. In many NPD studies, generating ideas and the activities related to the front-end are regarded as key factors in determining the success of products and businesses (e.g. Argument et al., 1998; Bhamra, 2004; Steven & Burley, 2003). Also, this study explores companies whose average ranking of turnover has been in the top ten in the global market for the last decade, since the success of a business is mainly evaluated by its revenue and profit (Pulic 2004).

To respond to the recent and rapid changes in society, in which diverse knowledge has been interlaced in a complex fashion, companies have recognised the importance of a synthesis of ideas from various knowledge areas (Brown, 2008; Hatchuel et al., 2010; Janssen & Goldsworthy, 1995; Negroponte, 2003; Nissani, 1997). Moreover, the current NPD projects of MNEs are mainly carried out through cooperation between various functional teams, because recent NPD processes are normally regarded as being activity-centred systems that are knowledge-based and cross-functional (Lawson et al., 2009; Negroponte, 2003). Therefore, this study explores in depth the differences in idea generation activities and viewpoints between the different functional groups at each stage of the front end, while investigating what emerging issues are related to these differences. In addition, it identifies factors that influence the generation of innovative ideas, which can effectively contribute to actual product development through a synthesis of the findings from the investigation.

Review of Relevant Literature and Theory

Theoretical studies have used a multi-theme model of investigation for literature reviews. The literature review herein was implemented to examine existing issues in front-end studies relevant to idea generation, and thereby to extract key issues to compare with the findings from the subsequent empirical study. This study focused on the differences in perspectives and activities between various expertise groups in the front-end phase and examined the reasons how and why these differences had an impact on actualising ideas into real products.

In particular, through preliminary reading focusing on the above themes, the author realised the importance of understanding and exploring areas of uncertainty and the use of data, information, and insights of various expertise groups, in order to achieve crucial discoveries in idea generation and development research for NPD.

Hence, the theoretical aspect of this paper specifically explores the following three distinct but interrelated themes in order to obtain core information about idea generation and development practices in the front-end phase:

- Factors Affecting Front End Innovation (FEI) and Idea generation
- Factors Affecting Uncertainty in Early Stage (ES) of NPD
- Factors Affecting Usage of Data, Information and Insights (DII) within Idea Generation Activities in Early Stage (ES) of NPD.

Research Questions

Critical analysis of these three main issues identified in the literature review contributed to building the themes in the following four research questions (RQ), along with related sub-issues:

RQ1: What are the current nature of the idea generation processes and the importance of idea quality in ES NPD processes?

Sub-issues examined to address RQ1:

- Nature of the idea generation processes of MNEs
- Importance of idea generation activities and idea quality in ES of NPD by MNEs
- Factors considered by each expert group when defining idea quality

RQ2: What are the reasons for initiating new projects, and what is the nature and level of involvement of various functional groups in the idea generation phase?

Sub-issues examined to address RQ2:

- Reasons for starting NPD
- Importance and effectiveness of each expertise group's involvement in generating ideas
- Frequency of each expertise group's involvement in the idea generation stage
- Primary activities of each expertise group during the idea generation and development phases

RQ3: What are the factors that affect uncertainty when generating and developing new ideas?

Sub-issues examined to address RQ3:

- Understanding the specific stages at which each expertise group encounters uncertainty in the idea generation and development phase
- Reasons for encountering uncertainty while generating new ideas
- Importance and effectiveness of communication between the expertise groups in reducing the level of uncertainty when generating ideas

RQ4: What data types, resources, and formats are typically used in stimulating or generating new ideas?

Sub-issues examined to address RQ4:

- Nature of MNEs’ use of data and information when generating ideas
- Nature of use of data, information, and insights that are typically used by each expert group in order to stimulate generating ideas
- Frequency of the use of the data, delivered from internal research division, by each expertise group when generating new ideas

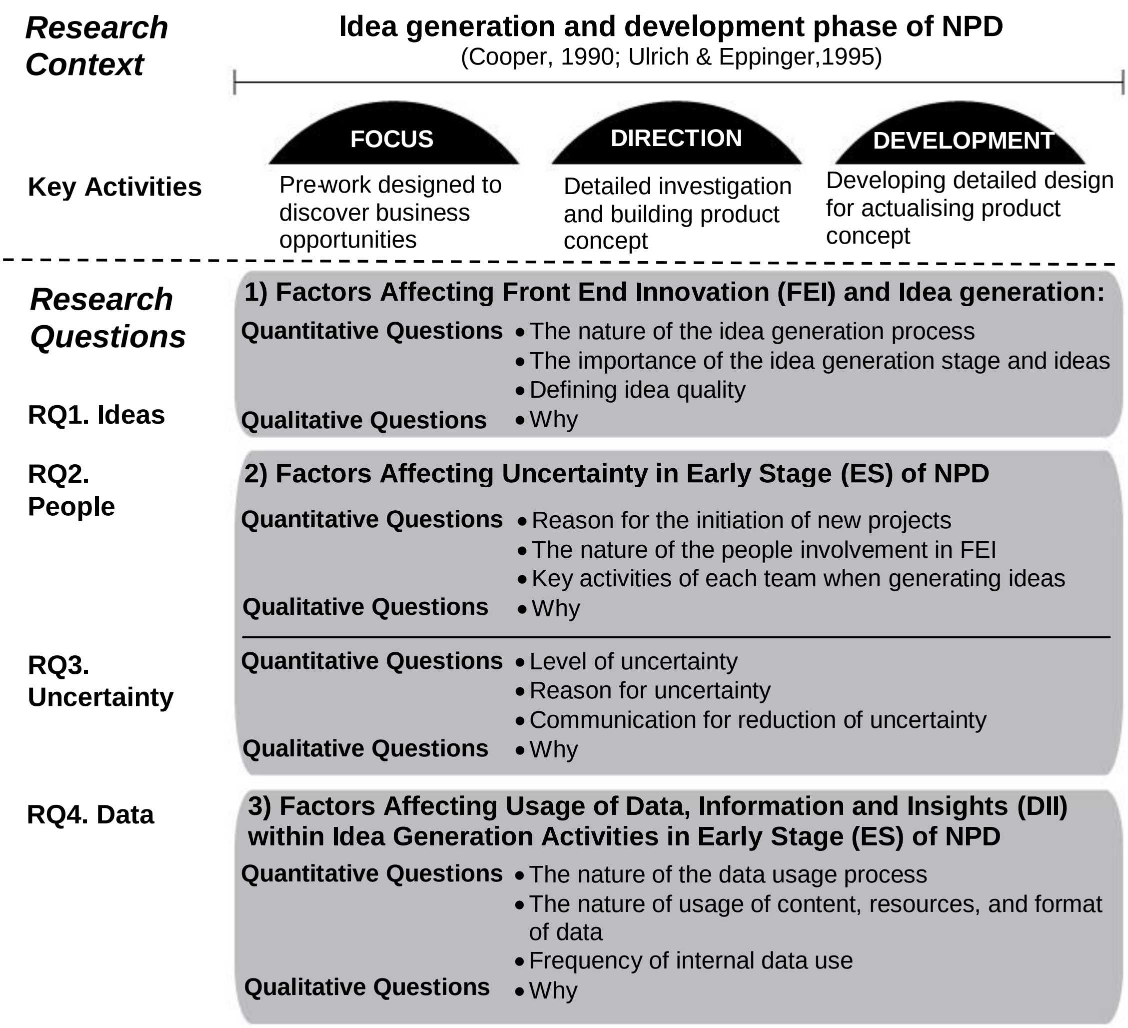


Figure 3. Exploratory research framework: extraction of theory for designing RQs

Data Collection and Analysis

To identify common or different perspectives when generating ideas between the different types of expertise groups (Denscombe, 2014; Krueger, 2014), this study conducted a set of three interviews with various expert teams (planning, design, and engineering) from four major multinational companies in the fields of smart electronics and the automobile industry. The four sample companies range from 75,000 to 325,000 employees and earn £37 billion to £133 billion in sales a year. In addition, global revenue rankings ranged from 1 to 11 in their industry sectors for the past decade (2007 to 2017). Also, the companies commonly operate planning, design and engineering teams as their primary teams for NPD activities.

The document for the empirical study was built based on the main results of the literature review. It adopted a triangulation methodology (Webb et al., 1966), a hybrid method using quantitative and qualitative research. This mixed concept can enhance the findings of an empirical study by complementing each quantitative and qualitative research's limitations (Jick, 1979), and it is useful in human behaviour studies related to specific situations (Cohen & Manion, 2000; Van Bruggen, Lilien, & Kacker, 2002). For collecting quantitative data, this study used the Likert scale method, since it is useful for seeing an overview of participants' thoughts or attitudes and for measuring positive or negative trends in relation to a particular subject (Bordens & Abbott, 2002; Monteleone & Torrisi, 2012). For collecting qualitative data, this study adopted a semi-structured methodology. This method enables interviewees to provide reliable, comparable qualitative information relevant to the subjects in question, because the interviewees can freely express opinions from their own viewpoints. Also the conversation contents do not deviate much from the inquiry domain (Britten, 1995; Cohen & Crabtree, 2006). This study used the Kruskal-Wallis test to analyse quantitative interview results, which is often adopted when comparing two or more samples of the same or different sizes, especially when sample sizes are small and unequal (Kruskal & Wallis, 1952; Schmider et al., 2010; Zaiontz, 2014).

Also, the study utilised the content-analysis method for the qualitative study, which drives objective, systematic inferences through identifying specified characteristics of interviewees' responses (Holsti, 1969; Michelle, 2012).

Findings

The findings chapter comprises the results of three sets of studies: pilot, main, and validation. It identifies the key factors that affect difficulties with the front-end activities, which are acquired from the synthesis of each study's findings.

The purpose of the pilot study was to comprehend the overall context of the recent idea generation and development process in the early part of NPD, so that the subsequent interviews would accurately explore crucial issues related to front-end activities. The main study explored the nature of the idea-generation process of MNEs and investigated the key factors that affect uncertainty and mistrust when generating ideas, which is the primary goal. The validation study of this thesis confirms the findings from the main study and explores the reasons for the main study's findings in depth via referring to the examples offered by interviewees.

Through synthesising the outcomes of the three studies, the final part of the findings chapter concludes by summarising the key factors that influence difficulties in actualising ideas for innovative products in the front-end stage.

Discussion

The main purpose of the discussion section is to discover the conformance and contradictions between theoretical findings from the literature review and the practical issues found in the actual idea-generation process inside sample MNEs. This discussion has been used to strengthen existing knowledge through in-depth investigation of the gaps between the theoretical issues and those emerging from real practice in the industry. It also supplies potentially distinctive new knowledge to improve the idea-generation process in both academic and real-world practice area.

Conclusion

The conclusion chapter summarises the research and highlights the key findings acquired from answering the study's main research questions. In addition, it provides a revised framework and opportunities to solve recent issues related to difficulties with idea generation activities in the front-end phase of NPD.

Furthermore, the contributions and limitations of this study are addressed and the meanings of the results explained, as well as any need for future, related research.

Research Structure

		Purpose	Methodology	Key Themes	Key Words
Theoretical Study	**Literature Review**	To understand and extract the key issues in the literature about idea generation activities on the front end of NPD	Multi-theme investigation via journals, conference papers, and books related to key words	(1) Front End Innovation (FEI) and Idea generation (2) Uncertainty in Early Stage (ES) of NPD (3) Usage of Data, Information and Insights (DII) within Idea Generation Activities in Early Stage (ES) of NPD	NPD, front-end, idea generation, idea integration, design thinking, uncertainty, idea management, types of data
Empirical Study	**Pilot Study**	To comprehend the overall NPD processes of industrial MNEs	Data collection: Triangulation methodology; Likert scale & Semi-structured methodology Analysis: Kruskal-Wallis test & Content-analysis method	(1) Ideas and the Nature of Idea Generation Process (2) NPD Initiation and People Involvement (3) Uncertainty in Idea Generation (4) Data, Information and Insights (DII) that Stimulate Generating Ideas	NPD, front-end, idea quality, multidisciplinary team, uncertainty
	Main Study	To discover core issues in the recent idea generation practice of MNEs			ideas, people involvement uncertainty, mistrust, stimulus data
	Validation Study	To validate the results of the main study and to obtain feedback			Inefficient system, common language, feedback channel, uncertainty, mistrust,
Synthesis of Studies	**Discussion**	To strengthen findings and enrich the knowledge area	Comparison of issues between theoretical and empirical studies	(1) Ideas and the Nature of Idea Generation Process (2) NPD Initiation and People Involvement (3) Uncertainty in Idea Generation (4) Data, Information and Insights (DII) that Stimulate Generating Ideas	Inefficient system, internal conflicts, people involvement, different language, uncertainty, mistrust,
	Conclusion	To provide adjusted framework and opportunities	Summary and synthesis of the results of each chapter	Reducing level of mistrust and uncertainty; improving level of using internal data	cross-functional tasks, idea integration, mistrust, uncertainty, research to practice

Table. 1. Summary of research structure

2. **Literature Review**: Front-End Innovation and Idea Generation, A Review of Extant Literature

Introduction

The purpose of this literature review is to identify the factors affecting issues that MNEs currently face when attempting to generate innovative ideas in the early stages of NPD processes, especially via cross-functional teams.

Rapid changes in technology and market conditions are creating an environment where large organisations need to have measures in place to reduce uncertainty when using a large amount of data and operating idea generation processes (Garnsy & Heffernan, 2005; Ledwith et al., 2006; Pink, 2006).

Specifically, these changes brought a market environment in which consumers seek to purchase emotional satisfaction, not only physical functionality (Pink, 2006; Verganti, 2009). For this reason, many studies of NPD focus on design thinking that adopts distinctive design characteristics by synthesising disparate elements for new opportunities (e.g. Brown, 2008; Lockwood, 2010; Martin, 2010; Verganti, 2009).

Therefore, exploring the following three themes related to these NPD tendencies and building a comprehensive understanding of key issues from each theme will help to identify factors that affect the NPD process in a rapidly changing market environment:

2.1. **Factors Affecting Front End Innovation (FEI) and Idea generation**

2.2. **Factors Affecting Uncertainty in Early Stage (ES) of NPD**

2.3. **Factors Affecting Usage of Data, Information and Insights (DII) within Idea Generation Activities in Early Stage (ES) of NPD**

This chapter focuses on reviewing multiple high-quality resources, including renowned journals and books published over the last few decades, mainly from 1991 (see p. 95), in various academic areas relevant to NPD (e.g. innovative ideas, idea generation stage of NPD, design thinking, cross-functional tasks, internal conflicts, project uncertainty, and efficient use of data). Also, this literature review explores the causal relationship between emerging issues identified in different studies.

In much of the innovation literature, creativity is defined as a precondition for successful innovation (Bassett-Jones, 2005). Namely, creativity emerges while generating new ideas, comprises new knowledge, and builds a basis for innovative approaches (e.g. Amabile et al., 1996; Bessant, 1998; Pratt & Jeffcutt, 2009; Van de Ven et al., 1999).

Specifically, in NPD research, innovative business is often defined as something that has an economic impact in the market by introducing new processes, opening new markets, and establishing new organisational forms (Eisenbeiss et al., 2008; Li & Atuahene-Gima, 2001; Tuomi, 2002).

This study also defines innovation as a condition that affects business success and regards creativity as one of the necessary factors for achieving innovative business. In addition, it examines external uncertainty as an environment in which it is difficult for information to reflect market or technological change promptly, and where it is difficult to forecast future circumstances (MacCormack, Verganti, & Lansiti, 2001; Spender, 1993). It also investigates internal uncertainty as a lack of conviction in the decision-making and quality of ideas, which are affected by external uncertainties (Oh et al., 2012; Sarin & McDermott, 2003).

The first section explores three themes related to the overall market environment, the importance of synthesised thinking (design thinking), and the ideas that affect the successful idea generation of NPD. It also conducts in-depth reviews of the factors that influence innovative idea generation in the subdivided themes.

The second part of the literature review critically explores the factors driving uncertainty in the initial phase of the cross-functional tasks-oriented NPD process. To determine this, it firstly examines the nature of existing NPDs' frameworks and the theoretical models mainly used by MNEs.

In particular, this study investigates issues emerging from the internal relationship between different functional people and teams, since the issues relevant to cross-functional tasks are core factors affecting the uncertainty of NPD (Hatchuel et al., 2010; Lam & Chin, 2005; Lawson et al., 2009; Moenaert et al., 1995; Negroponte, 2003; Pelled & Adler, 1994).

The third section explores elements that contribute to the effective use of data, information, and insights, and that might lead to better opportunities for companies

to create innovative ideas and reduce uncertainty (Kusiak & Tang, 2006; Lesser et al., 2000; Memmi, 2014). To explore such elements, this section carries out a thorough review of theoretical knowledge in simplifying data and information, and using data effectively in stimulating innovative ideas.
This literature review assumes that key topics for enhancing front-end performance are reducing uncertainty in the front-end phase and the quality of ideas; therefore, this theoretical study searches for the rationales behind them.

As new products become ever more complex in trying to incorporate various market needs, collaboration with multiple functional teams is increasingly important in current NPD processes in MNEs in order to reduce uncertainty (Negroponte, 2003; Olson et al., 1995; Song et al.,1998). Hence, this literature review examines studies of ideas and of the idea generation process; issues related to employees and their cross-functional activities; and the use of data, information, and insights in the early stages of NPD, in order to discover theoretical clues that can improve the idea generation processes of MNEs.

2.1. Factors Affecting Front-End Innovation (FEI) and Idea Generation

Introduction

The literature review explores existing and emerging knowledge related to new ideas and innovation. In this first section, this paper examines recent circumstances and environments in which multinational companies (MNEs) might face difficulties when approaching successful NPD, and investigates new paradigms that can affect their innovative performance. In addition, crucial definitions of idea study fields are identified in order to find opportunities for improving the quality of new ideas.

This subject consists of three sub-themes:

2.1.1. Factors Affecting FEI Performance
2.1.2. Design Thinking
2.1.3. Importance of Idea Quality

A consideration of the factors affecting front end innovation (FEI) and idea generation will help identify how companies can react to unexpected situations within the unstable market atmosphere, so that they can obtain successful NPD results.

2.1.1. Factors Affecting FEI Performance

Uncertain Business Environment

Today's market and business environment is characterised by remarkably fast changes in society, and it is strongly influenced by uncertainty (Cross, 2001; Hatchuel et al., 2010). To respond creatively to these complicated environments and market circumstances, many firms today continually try to: (1) establish new collaborations with various organisations, and (2) seek novel opportunities in their business by investigating new patterns of consumer behaviour or social networks

(Sarasvathy, 2001). Also, those new challenges and explorations of new ways for adapting to uncertain business environments tend to be expected to work on contingency, despite an unpredictable future and radical movement on the part of industry (Sarasvathy, 2001; Warren & Fuller, 2009). Given this complex situation, these efforts can lead to the co-evolvement of each organisation involved in cooperative projects (Garnsy & Heffernan, 2005). To be market leaders in this environment, entrepreneurs are required to strategise on the basis of a contingent, unpredictable future (Sarasvathy, 2001) and in the face of fast-moving technological and industrial changes (Garnsy & Heffernan, 2005).

Pink (2006) has stated that we are now living in an era of abundance; that today's society and technology are changing very fast, and goods and services have been developed and diversified to a remarkable extent. These changes have led consumers to buy emotional satisfaction according to their own tastes, not only to seek typical considerations such as product functionality (Pink, 2006; Verganti, 2009). This is because there are too many other options (Pink, 2006). To react properly to this change within the competitive market environment, companies are increasingly required to consider more innovative platforms for establishing their new product concepts, rather than adhering to their existing platforms (Ledwith et al., 2006; Pink, 2006).

Ries (2011) is concerned about companies focusing only on their attractive strategy, which is mainly analysed and generated by existing market research methods. In earlier business environments, these kinds of typical approaches mostly resulted in successful results; however, these days it is more difficult, because recent enterprises operate their businesses with too much uncertainty, which makes it harder to predict the future (Ries, 2011). The difficulties involved in setting reactive approaches for environmental changes impel firms to generate and develop their own specific tactics proactively and effectively, which are mainly redefined on the basis of market competition (Hagel, Seely Brown, & Davison, 2008; Hamel & Prahalad, 1991; Kim & Mauborgne, 1997).

Disruptive Thinking for Innovative Approach

Many scholars and inventors have presented varying views about ways of thinking for achieving success in the innovative approach. One of the main arguments on the issue involves the obstructive factors that affect new way of thinking.

Pink (2006) agreed with Trevor Baylis' statement that convention-sided thinking only is the enemy of progress, and Williams (2010) suggested finding alternative ideas instead of existing ways to achieve innovation. Martin (2009) commented that to settle for previously explored data and to refrain from finding new ideas causes companies to miss a competitive opportunity.

In other words, a number of researchers consistently concern about the obstructive elements that cause firms to hesitate to apply novel methodologies. Why are firms reluctant to apply alternative methodologies to their main ideation process? Williams posited the importance of disruptive thinking and stated that "The reason most disruptive hypotheses fail to make it past the 'what if' stage isn't that they are too radical; it is that the advantages of the disruption are not clear" (2010, p. 41). For example, decision-makers such as project directors or executives in organisations seeking innovative outcomes still tend to depend on typical results related to a high level of reliability, whereas designers or creators prefer to rely on results associated with validity (Martin, 2006).

Most managers make decisions through verified methods linked to analytical thinking, and these methods are well organised for exploiting existing knowledge (Brian, 2010). However, design institute theorists suggest that 'abductive reasoning' is required as a form of new logic for innovative thinking, and that generating a new type of data and methodology might be the only way to validate it, instead of typical processes such as prototyping or testing in business applications (Brian, 2010).

Making an effort when investigating alternatives to the most evident approaches is regarded as an important opportunity to break away from clichéd ideas. These changes usually occur in similar categories, but these are not necessarily very different or competitive categories (Martin, 2009; Williams, 2010). The theorists who support these new challenges are concerned by the fact that most researchers are focusing only on the most remarkable problems. However, it is worth considering that the richest opportunities for innovation are often in areas that seem unbroken or very small, because the opportunities tend to be hidden by little things that have not been changed or fixed for a long time, since they are easily ignored and do not receive much attention (Williams, 2010).

Also, Williams (2010) brought up an additional discussion in that there are three crucial obstructive matters during the transformation of new opportunities into ideas, as shown in organisations' projects: (1) lack of focus on developing ideas, (2) relying on thinking of isolated resources when generating new ideas, and (3) lack of visualising ideas (see Table 2).

1. Teams' and individuals' overwhelmed, directionless feeling, and **lack of focus**. *'In my experience, this is a direct result of relying on traditional brainstorming approaches. If your ideas are going to have any disruptive impact, you need to move beyond a shotgun approach to brainstorming and start pursuing creative effort with a laser-sharp focus.'*
2. Relying on **thinking** of the world in terms of **isolated** products, services, and information. *'We need a new mind-set when it comes to generating ideas: one focused on the dynamics of a blended whole, rather than the details of its isolated parts. That said, don't slip into thinking of disruptive ideas only in relation to new gadgets and technology. You can develop disruptive ideas for any opportunity you desire.'*
3. **Undervaluation of visualising** *'You can talk about ideas in general terms, at least for a while. However, abstraction makes it harder to understand an idea and remember it. So, to increase the potential, you have to stop talking about it and explain it in sensory terms. Ambiguity disappears when you describe your ideas in visual or written form.'*

Table 2. Three major stumbling blocks to converting new opportunities into ideas (Williams, 2010, p. 80-82)

Disconnection between Research and Practice when Designing New Products

'Research (Theory)' and 'Practice (Realistic)' are both regarded as important elements when designing new products. A number of studies in innovation and new product design tend to concur with this, and they also noticed the difficulties when transferring their knowledge and data into actual practice. Although many companies struggle to develop their own specific methods for transitioning their research data into their new product outcomes, these activities are still the most difficult to achieve (Buchanan, 2001; Gregor et al., 2007; Hubbard, 2010; Pugh, 1991). In other words, companies often face difficulties in achieving specific practice outcomes using the research results they have collected (Buchanan, 2001; Cross, 2001).

Moreover, this phenomenon of finding the transitioning methodologies between research and practice has occurred not only in the business field, but also in the academic field. According to Buchanan (2001), many academic organisations related to design have started to discover a dynamic balance between the theory and practice of designing products, beyond only maintaining or developing the theoretical status of the arts and design. This phenomenon shows that many researchers have realised that design study has its own strong and appropriate intellectual culture, which is very different from that of other subjects (Cross, 2001; Schon, 1983).

Multiple design studies considering the importance of and difficulties between research and practice also reflect on the effectiveness and influence of the systematic methodology of applying theory to practice (e.g. Hubbard, 2010; Pugh, 1991; Swann, 2002). Hubbard (2010) and Pugh (1991) observed that difficulties in transferring data and knowledge between research and practice activities may emerge from a lack of proper systematic methodology in the process.

They believe that well-organised systematic methodologies can be helpful for organisations to make a successful transition from theoretical research data into practical design outcomes (Buchanan, 2001; Gregor et al., 2007; Hubbard, 2010; Pugh, 1991). Swann (2002) expressed the meaning of design research as a demonstration of systematic inquiry into tangible design outcomes, and Mike Press (1995) illustrated that “a designed artifact is a researched proposition for changing reality” (Swann, 2002, p.52).

Learning from Failure and Pivot Points

Ries (2011) has noted that, in earlier business markets, a solid plan and strategy was regarded as a foundation for business success, whereas the value of this hypothesis has been doubted in recent times. This is because many businesses often operate with a great deal of uncertainty, the market is becoming more uncertain, and it is becoming harder and harder to predict the future (Cross, 2001; Hatchuel et al., 2010; Ries, 2011; Ruekert et al., 1987).

Many firms often encounter difficult challenges in developing products, whether pivoting to another route or persevering (Ries, 2011). Generally, many organisations are unhappy about having to change plans, as they often feel that it signifies failure. However, Ries (2011) explained that changing a plan is not a failure; instead, he called it a pivot point, or another way to approach success for the same goal.

Majaro (1991) noted that, when considering problems, this brings about multiple new opportunities. A number of authors who have written about failure and mind-sets have suggested that experiencing failure is a way of learning (e.g. Bonabeau et al., 2008; Cusin, 2012; Scott et al., 2000; Sitkin, 1992). Hartford (2011) asserted that no failure means no learning, while Cusin (2012) also illustrated that failure might convert to a special knowledge.

In particular, to acknowledge failure promptly and spin the experience into an opportunity for success may be an important requirement for enterprises seeking innovation (Cusin, 2012; Feitelson, 2013). For example, Feitelson (2013) explained how failure is treated in the culture of Facebook, which is famous for being a highly innovative enterprise. Rather than blaming the people involved, Facebook sees failure as a juncture for improving its business. Failure is a significant experience, rather than a thing to chastise people for (Feitelson, 2013).

In their papers, Bonabeau et al. (2008) quoted interviews with several executives to describe the mindset of failure; many firms already noticed that fast and evidence-based failure would be helpful to increase organisations' NPD productivity.

To bring learning from failure into the pivotal point strategically, it is useful to examine the classifications of Edmondson (2011) and Sitkin (1992) (Clerkx, 2016; Scott & Vessey, 2000). Edmondson (2011) divided failure into three different types: (1) preventable, (2) unavoidable, and (3) intelligent. According to him, preventable failures are normally caused by people's mistakes or lack of ability on projects, and unavoidable failures occur from unexpectedly complex situations, such as members' loss of interest about the projects. Intelligent failures enable new information generated from the experience to be transferred to beneficial changes, which is helpful in enriching final outcomes. Sitkin (1992) also presented the need of companies to attempt to find lessons from experiences of failure, rather than looking at how to avoid it.

Sitkin (1992) described several specific preconditions that may allow more effective transitioning from failure to opportunities: '(1) deeper processing of information about potential problems; (2) greater recognition of problems based on past experience; (3) deeper levels of search; (4) an organization that is more flexible and open to change; (5) a greater level of risk tolerance; (6) a greater variety of personnel and organizational procedures; and (7) a greater experience available to address future problems' (Scott & Vessey, 2000, p. 217; Sitkin, 1992).

2.1.2. Design Thinking

Design Thinking

The concept and definition of design thinking has been explored by many studies in the innovative business field (e.g. Brown, 2008; Martin, 2010; Verganti, 2003). Although they investigated the character of design thinking from various viewpoints, their research found a common notion of design thinking; the harmony and balance of contradictory or diverse types of human-centred knowledge.

Pink (2006) has argued that we have lived in an era of continued abundance, an age that has brought about many changes in the types of service, knowledge, and consumer needs within innovation's terrain. Physical function is no longer the only attraction when customers buy products, and new needs for a human-centred approach through the 'design thinking' process have arisen (Brown, 2008).

Numerous scholars have introduced 'design thinking' as the creative solution to problems involved in innovative management in organisations, which pursue more integrated, human-centred, and synthesised processes. They have noted the similarities between recent social phenomena and how abundances have unleashed the need for sensibilities such as beauty, spirituality, and emotion, and for those sensibilities to be reasonably priced and adequately functional – all of which is relevant to the integrative thinking and distinctive nature of 'design' (Brown, 2008; Hatchuel et al., 2010; Lockwood, 2010; Pink, 2006).

Tim Brown of IDEO, defined design thinking as "a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (Brown, 2008, p. 86). He commented that companies are asking designers to create new ideas that meet consumers' complicated needs and desires, since companies are keen to unearth innovative outcomes within the new circumstances of today's generations (Brown, 2008).

The world is moving from industrial manufacturing to knowledge works. Brown believes that design thinking can make a decisive difference, which leads to human-centred activities (Brown, 2008). Also, the majority of recent studies about design thinking deem that it has contributed to a shifting competitive logic of business, from price or quality-centred products to a combination of ineffable and emotional factors such as novelty, beauty, and meaningfulness (Brown, 2015; Jocelyn Wyatt, 2015; Pink, 2006). Verganti (2009) says that "design thinking is very deeply relevant to design-driven innovation, since it is aimed at creating new market opportunities based on emotion-rich innovations in product meanings" (p. 5). Also, Professor R. Martin of the Toronto Business School emphasised the property of design thinking in that "design thinking and the design of business need balancing exploration and exploitation" (Martin, 2010, p. 39).

For these reasons, many business and management experts within companies believe that more design thinking could help bring about innovative ways to solve problems across many professions, and they expect to achieve significant quality conversations and decisions in their future business (Clark & Smith, 2008). In other words, in an age of abundance, appealing only to rational, logical, and functional needs is an insufficient method by which to lure people to make their purchases, because there are too many other similar options in the market (Pink, 2006). Furthermore, design thinking is now involved in processes, systems, and organisations (Neumeier, 2009). Therefore, many researchers and experts agree that the greatest demand today in the industrial market is not only analysis, but also a synthesis view, such as seeing the big picture, crossing borders, and combining disparate pieces and assembling them for the new whole (e.g. Martin, 2010; Negroponte, 2003; Pink, 2006; Toubia, 2006; Verganti, 2003).

Design Thinking; Balance between Rational and Emotional Thinking

Historically in human science, the rationale and theory went that the left hemisphere was the crucial half that made us human, while the right hemisphere was subsidiary (Pink, 2006). The following theorists showed the new need for combining rational and emotional ways of thinking through scientific evidence. For example, Chris Manus, Professor of Psychology and Medical Education, University College London (2002), cites the importance of both ways of thinking. He explained this pattern as follows:

> *However tempting it is to talk of right and left hemispheres in isolation, they are actually two half-brains, designed to work together as a smooth, single, integrated whole in one entire, complete brain. The left hemisphere knows how to handle logic and the right hemisphere knows about the world. Put the two together and one gets a powerful thinking machine. Use either on its own and the result can be bizarre or absurd.*

Furthermore, Roger Sperry, a professor at Caltech (1968), discovered the effectiveness of balance by using both hemispheres in his study involving patients whose corpus callosum had been removed. “The left hemisphere reasoned sequentially, excelled at analysis, and handled words. The right hemisphere reasoned holistically, recognised patterns, and interpreted emotions and nonverbal expressions. A human being, therefore, is literally of two minds” (William, 2014, p. 13)**.** This research helped Sperry win a Nobel Prize in medicine. As many researchers discovered, it is natural for the left and right hemispheres to operate at the same time, in the same proportion. According to Pink (2006), “the two hemispheres of our brains, in fact, are formed to complete the brain through mutual cooperation” (p. 5), “and don’t operate as on-off switches – one powering down as soon as the other starts lighting up. Both halves play a role in nearly everything we do” (p. 17). By saying this, William does not imply only the importance of the emotional factor in our way of thinking through the right hemisphere; he does say that left-directed aptitudes are still necessary. Instead, the need for characteristic thinking by both left- and right-directed aptitudes has soared increasingly in today’s industry, which is challenging itself to seek innovation.

F.G. ‘Buck’ Rogers, one of IBM’s most notable salespeople, famously said, ‘Customers buy on emotion and then justify with logic.’ It means that considering the emotional point of view when selling and developing new products and thinking about consumer needs is deeply relevant to business success. To enhance innovative business strategies, design thinking is remarkably well suited to actualise these desires with its own character, embracing both rational and emotional thinking (Clark & Smith, 2008).

As has been described so far, design thinking involves considering both rational and emotional thinking. Design thinking can lead to innovative methods that go beyond appearance and aesthetics; yet, it does not indicate that form and aesthetics are not necessary for developing innovative ideas (Brown, 2008).

> *The i-pod was not the first MP3 player, but it was the first to be delightful. Target’s products appeal emotionally through design and functionally through price – simultaneously. (Brown, 2008, p. 92)*

All of these studies reveal a concern that, if companies do not consider the effectiveness of the balance between rational and emotional thinking for their new product development process, then their competitiveness in the market can be potentially reduced (Clark & Smith, 2008; Lockwood, 2010; Martin, 2010; Pink, 2006).

Design Thinking; Balance between Conventional and Explorative Thinking

Many companies tend to rely on the conventional methods of the decision-making process, as they have confidence in these familiar processes and habitually use them (Campbell et al., 2009; Martin, 2009; Pink, 2006; Schon,1983; Williams, 2010). Companies usually come to a decision by using emotional tags (conventional thoughts), leap to a conclusion without a median process, and are reluctant to consider alternatives. In particular, people are not used to reconsidering their initial assessment of the specific situation (Campbell et al., 2009).

Many scholars have pointed out the need to find alternative ways when developing ideas, rather than relying on existing methods (Martin, 2009; Pink; 2006, Williams, 2010). Furthermore, Martin (2009) emphasised that mastering a balance between existing and new methods will foster the most successful businesses in the future. Hence, analysing the pros and cons of a conventional process and exploring new ways might be beneficial for achieving innovative NPD outcomes.

2.1.3. Importance of Idea Quality

Significance of idea quality improvement in the idea generation stage

Idea quality is regarded as a crucial requirement of an innovative process and a measure of its success (Koc & Ceylan, 2007), and a great number of companies and theorists emphasise the necessity of systematic methodologies in the idea generation stages to maximise the quality of their ideas (Flynn et al., 2003). A number of theorists hold that the idea generation stage is significant in the NPD process because the investigation of opportunities leading to NPD success are implemented in this stage (e.g. Christensen et al., 2008; Cooper, 1997, 2001; Kim & Wilemon, 2007; Koen et al., 2001; Murphy & Kumar, 1997; Nobelius & Trygg, 2002). Rochford (1991) stated cost effect as one of the reasons why many companies focus on the idea generation stage: it is comparatively less costly than the later product development stage when adjusting a plan or direction.

From an awareness of the benefit of idea quality improvement in the idea generation stage, firms are struggling to establish specific methodologies in this stage (Fraser, 2009; Hatchuel et al., 2010; Ries, 2011;). Their goal is to ensure successful outcomes by obtaining high-quality ideas before they embark on making a prototype (Björk & Magnusson, 2009). Although multiple scholars and theorists have sought answers from empirical case studies (Bretschneider et al., 2012), many of their results have been equivocal (Barki & Pinsonneault, 2001).

Idea Quality and Idea Quantity

Idea quality and quantity have been discussed actively in the study of ideas (e.g. Aiken et al., 1996; Briggs et al., 1997; Connolly et al., 1990; Gallupe et al., 1991; Gryskiewicz, 1988; Osborn, 1953; Reinig & Briggs, 2008; Rietzschel et al., 2007; Shepherd et al., 1996). Specifically, many theorists and scholars in this field have investigated the relationship between the two (idea quality and quantity) (Dennis et al., 1997, 1999), whereas, in the past, idea generation studies have not significantly addressed the theoretical relationship between them (Gallupe et al., 1992; Gurman 1968; Petrovic & Krickl 1994; Reinig & Briggs, 2008). Three leading views on the relationship between the quality and quantity of ideas were identified in the literature review: (1) the idea quantity-focused method, (2) the idea quality-focused method, and (3) a synthesis of the two methods.

(1) Idea quantity-focused method

According to Reinig and Briggs (2008), some researchers of idea generation studies (e.g. Dennis et al., 1997, 1999; Osborn, 1953) agreed that idea quality follows quantity. Also, these theorists commented that it is not necessary to evaluate idea quality, since the quality of ideas is subordinate to the quantity of ideas (Gallupe et al., 1991; Shepherd et al., 1996). As stated by Osborn, “it is almost axiomatic that quantity breeds quality in ideation, the more ideas we produce, the more likely we are to think up some that are good” (Osborn, 1953, p. 131).

2) Idea quality-focused method

Meanwhile, the researchers who had conflicting views about the opinion that idea quality follows quantity (e.g. Aiken et al., 1996; Briggs et al., 1997; Connolly et al., 1990; Gryskiewicz 1988) stated that idea quality is not greatly related to idea quantity (Reinig & Briggs, 2008). In addition, they began to conduct tests to determine whether the theoretical prediction of the relationship between idea quantity and quality can be practically applied or not to the idea generation process (Aiken et al., 1996; Briggs et al., 1997; Connolly et al., 1990; Gryskiewicz 1988; Reinig & Briggs, 2008). Briggs et al. (1997) stated that Osborn's 'Quality follows Quantity' theory is the incomplete model, as they discovered that idea quantity did not show convincing examples of an intimate relationship with idea quality. They judged that 'quantity-centred' or 'quantity and quality's relationship-centred' theories are insufficient for forecasting and describing the trigger for idea quality. Also, one empirical test indicated a much stronger correlation between idea quantity and the number of bad ideas, than between idea quantity and the number of good ideas (Briggs et al., 2008, p. 405). Reinig (2008) found that the level of correlation between idea quantity and quality can vary, depending on the business situation, because circumstances in business these days are complicated (Cross, 2001; Hatchuel et al., 2010). Idea quantity might not always be effective when attempting to elicit high-quality ideas. Therefore, researchers of idea generation studies are requested to explore and develop new methodologies to improve the quality of ideas in the innovative ideation process directly, irrespective of their quantity (Reinig & Briggs, 2008).

3) Synthesis of idea quantity-focused and quality-focused methods
Another view of developing good ideas suggests a harmonised way of using both aspects. The theoretical analysis of a synthesis between idea quantity and quality might be useful for discussing the availability of Osborn's conjecture in innovative ideation processes, or it might be helpful to find out the reason for the inconsistencies between outcomes in empirical tests and results in the past ideation literature. It also might be useful to develop new ideation techniques for improving idea quality (Briggs et al., 2007).

Idea Quality Criteria

A quality-focused methodology is known to be very useful in idea generation research (Briggs & Reinig, 2010). Also, Barczak et al. (2009) found that new ideas normally have a short mean life, and only about 60% of them are actually chosen for NPD projects. Thus, in order to obtain good-quality ideas in a short period of time, many idea generation studies have considered how to evaluate the quality of new ideas and how to select the right one (Gressgård, 2012).

Idea-quality criteria typically consist of various key values relevant to the factors that potentially brought innovative outcomes in recent market circumstances (Bretschneider, 2012; Selart & Johansen, 2011). Hart et al. (2003) introduced the key criteria of idea quality (e.g. product uniqueness, market potential, market chance, technical feasibility, and intuition), based on the results of their previous investigation into companies' considerations when developing new products.

Also, Reinig et al. (2007) investigated idea quality by applying the average of multiple sources of criteria such as originality, technology, alignment with company goal, and consumer benefit. Bretschneider (2012) extracted the key elements for idea evaluation from previous research on idea quality (e.g. novelty, originality, paradigm relatedness, technical feasibility, economic feasibility, acceptability).

This study expanded and synthesised idea evaluation factors based on an in-depth exploration of studies by Bretschneider (2012), Hart et al. (2003), and Reinig et al. (2007). It categorised the findings into seven key factors: originality, feasibility (technical feasibility), capability (economic feasibility), business objective, market potential value, consumer benefit, and gut feeling (see Table 3).

Originality and Novelty

Crimmon and Wagner (1994) previously designated novelty as being one of the factors illustrating idea quality. 'Originality' and 'Novelty' are terms normally associated with rare, unique, unusual, or uncommon ideas (Connolly, Routhieaux, & Schneider, 1993). In other words, they refer to ideas that had not been expressed previously. The quality of non-obviousness denotes an idea that was previously unknown, even by people knowledgeable in the field (Crimmon & Wagner, 1994; Dean et al., 2006, p. 649). Reinig and Briggs' 2008 study on evaluating idea quality found that 97% of their research participants agreed that uniqueness was the key ingredient when considering idea quality.

Feasibility (technical feasibility) and Capability (economic feasibility)

Kramer and Kuo (1997) illustrated the importance of feasibility in technical and economical ways. Faure (2004) and Ozer (2005) agreed that an organisation's capability is a core factor when approaching high-quality ideas.

Business objective

Brem (2007, 2011) revealed that employees' consideration of business situations and aims may bring a high quality of ideas: It is affected by Linz's (2001) investigation about 'the importance of the quality of the business plan' and 'the capability of the business ideas in NPD processes of a company'.

Market potential value

Björk and Magnusson (2009) emphasised the new opportunities relevant to social and market networks. They stated that social network analysis is needed to prepare innovation tasks, and also agreed with Chesbrough's view (2004) that firms could benefit from adapting external sources of knowledge about new technologies or market trends for their innovative works.

Consumer benefit

Wirtz (2003) determined a correlation of customer satisfaction with firms' potential for prosperity in their industrial fields, as it is recognised as a main component for market success (Weiser, 1995). In particular, Wirtz (2003) investigated the impact of inexperienced consumers' evaluation of products or services; these customers use criteria they are familiar with, or else rely on their general impressions.

Gut feeling and Emotional attraction

The relation between ideas and 'gut feeling' has been actively explored, since selecting ideas and making decisions using individual judgement and feelings are common and usually inevitable (Kurkkio et al., 2011; Sadler, 2004). In their empirical results, Kastensson and Johansson (2011) found that the early stages of the project development process often address ideas not only with facts and actual figures, but also with gut feeling and intuition, as it is difficult to be elaborate at that stage. Eling (2014) introduced Hodgkinson's (2008) indication of gut feeling as a signal for the opportunity to forge a creative solution. According to Hodgkinson (2008), intuition might offer information if the ideas can be sustained through the product development process. People may recognise how much certainty they can put into ideas through continually checking the validity of their gut feeling compared with the rational approach (Sadler, 2004). As mentioned in the previous chapter, F.G. 'Buck' Rogers' famous saying also represents how the emotional factor can influence ideas in business: 'People buy on emotion and then justify with logic.'

Comprehending the emotional code for maintaining attraction is a crucial tactic for a successful business. To approach this goal, product appearance is also rated as one of the core strategic resources (Clark & Smith, 2008).

Component	Corresponding items
Originality/Novelty	An idea that has not been introduced before (Crimmon & Wagner, 1994; Dean et al., 2006; Hart et al., 2003; Reinig & Briggs, 2008)
Feasibility	Technical feasibility (Hart et al., 2003; Kramer & Kuo, 1997)
Business Objective	Strategic alignment to business objective (Brem, 2011; Brem & Voigt, 2007; Reinig et al., 2007)
Capability	Economical feasibility (Faure, 2004; Kramer & Kuo, 1997; Ozer, 2005)
Market Potential Values	Opportunities to lead market (Björk & Magnusson, 2009; Chesbrough, 2004; Hart et al., 2003)
Consumer Benefit	Consumer satisfaction through products and services that meet consumer needs (Reinig et al., 2007; Weiser, 1995; Wirtz, 2003;)
Gut Feeling	Instinctive feeling and intuition (Clark & Smith, 2008; Eling, 2014; Hart et al., 2003; Hodgkinson, 2008; Kastensson & Johansson, 2011; Kurkkio et al., 2011; Sadler, 2004; Tzokas et al., 2004)

Table 3. Idea quality criteria

2.1.4. Summary of Factors Affecting Front End Innovation (FEI) and Idea generation

The literature inquiry on factors affecting ideas and innovation showed the following key information for the companies seeking innovative NPD process:

- The ability to react to an uncertain and fast-changing market environment is a crucial factor in their NPD journey (Garnsy & Heffernan, 2005; Sarasvathy, 2001)
- To achieve successful outcomes in NPD, companies must look for new approaches instead of adhering to existing processes when generating ideas (Ledwith et al., 2006; Pink, 2006)
- Erudite people in the design thinking field revealed that the key notion for the design thinking process is the balance and harmony between opposite characteristics: between rational and emotional thinking and between conventional and explorative thinking (Brown, 2008; Lockwood, 2010; Martin, 2010; Verganti, 2009)

- A synthesis of the opposite types of elements such as ‘rational and emotional’ and ‘conventional and explorative’ thinking enables employees to generate innovative ideas (Martin, 2009; Pink; 2006; Williams, 2010)
- Failure is a valuable learning experience for achieving business success (Majaro, 1991; Ries, 2011)
- Applying research results to actual product development is challenging (Buchanan, 2001; Cross, 2001); however, a successful transition from research results to practical outcome is significant in NPD (Buchanan, 2001; Gregor et al., 2007; Hubbard, 2010; Pugh, 1991)
- High-quality ideas are important to the development of innovative products, and a number of idea studies have actively explored the criteria for evaluating the quality of ideas (Bretschneider, 2012; Hart et al., 2003; Reinig et al., 2007)

The knowledge gained through the literature review in this section has facilitated a deeper understanding of the factors that influence the challenges that companies typically face when generating ideas in NPD. Also, important and comprehensive information about the recent uncertain market environment was provided. Through examining existing theoretical discussions, the review has laid an excellent foundation for investigating opportunities for companies to obtain high-quality ideas in an uncertain market environment.

2.2. Factors Affecting Uncertainty in the Early Stages (ES) of NPD

Introduction

This second section of the literature review focuses on identifying the impact of internal or organisational factors on uncertainty and innovative outcomes, particularly within cross-functional tasks and processes, whereas the previous section explored external circumstances and environments that typically influence uncertainty.
To identify these factors, definitions and theoretical models that relate to the early part of the NPD process are reviewed. Preceding this, several hypotheses and elements discussed in key studies related to internal knowledge sharing and communication are examined.

This subject consists of three sub-themes:

2.2.1. Need for Idea Management in the Front End of NPD
2.2.2. Benefits of a Multidisciplinary Approach
2.2.3. Mistrust in the Internal Relationships

This literature review of the factors affecting uncertainty in the initial area of the NPD process will underpin this study. This will examine the significant correlation between people's levels of involvement in the ES of NPD and their levels of uncertainty on the projects.

2.2.1. Need for Idea Management in the Front End of NPD

New Product Development and the Front End

NPD Process and the focus of this study

Previous studies have established new product development (NPD) as a core process in the success of a manufacturing enterprise (Cooper, 1998; Craig & Hart, 1992). Many NPD studies have adopted the models developed by Cooper (1990) and Ulrich and Eppinger (1995) as the basic principles of their investigation (Ekerå et al., 2015; Trott, 2012).

To cover issues related to idea generation in depth, this study mainly focuses on the early part of these authors' NPD models: stages 0, 1, and 2 of Cooper's model (see Figure 4 and Table 4) and phases 0 and 1 of Ulrich and Eppinger's model (see Figure 5 and Table 5).

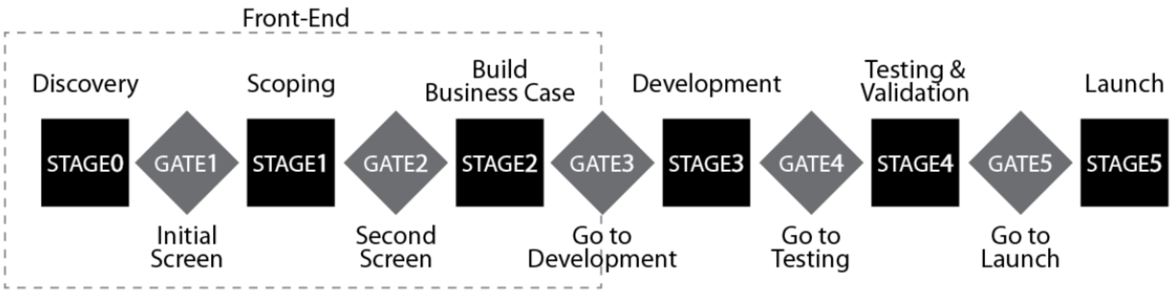


Figure 4. NPD process model (Cooper, 1990)

Range	Corresponding action
Stage 0	Pre-work designed to discover and uncover business opportunities and generate new ideas.
Stage 1	Quick, inexpensive preliminary investigation and scoping of the project (largely desk research).
Stage 2	Detailed investigation involving primary research (customer, market, and technical) leading to a business case that includes product and project definition, project justification, and proposed plan for development.
Stage 3	The actual detailed design and development of the new product and the design of the operations or production process required for eventual full-scale production.
Stage 4	Tests or trials in the lab, plant, and marketplace to verify and validate the proposed new product, brand/marketing, and production or operations plans.
Stage 5	Commercialisation: the beginning of full-scale operations or production, marketing, and sales.

Table 4. Idea-to-Launch (Stage-Gate®) model (Cooper, 1990; Edgett, 2015, p.4)

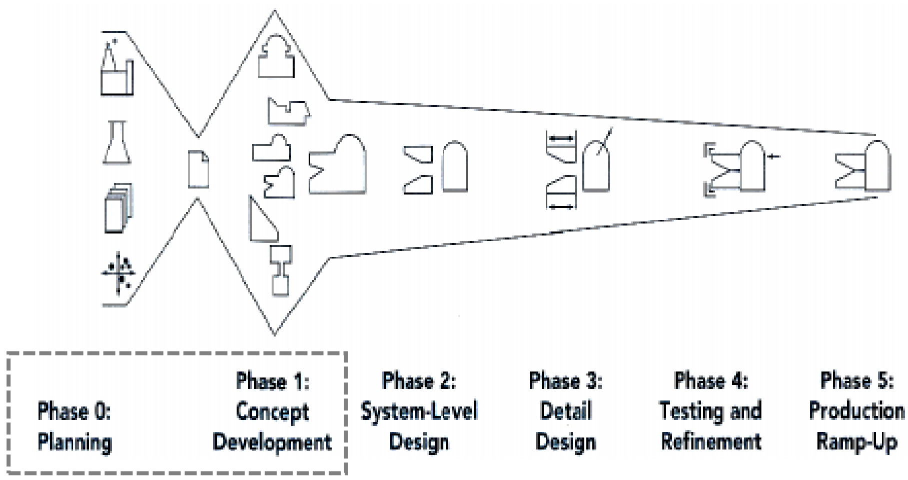


Figure 5. Generic product development process (Ulrich & Eppinger, 2007, p.14)

Range	Corresponding action
Phase 0	Planning project mission, business goal, key assumptions, and assessing technology development and market objectives.
Phase 1	Identifying target market, generating product concepts, selecting product concept, setting final specifications.
Phase 2	Generating product architecture and interface, decomposing products into subsystem or component, developing final assembly scheme.
Phase 3	Developing specification of geometry, materials, designing tools, planning cost effects.
Phase 4	Testing prototypes, implementing design changes for final products, refining fabrication and assembly processes.
Phase 5	Evaluating early production output, working out remaining problems, ready to launch.

Table 5. Planning-to-Launch model (Ulrich & Eppinger, p.14-15)

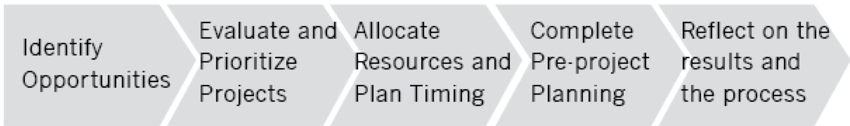


Figure 6. The sub-activities of Phase 0; Planning (Ulrich & Eppinger, 2007)

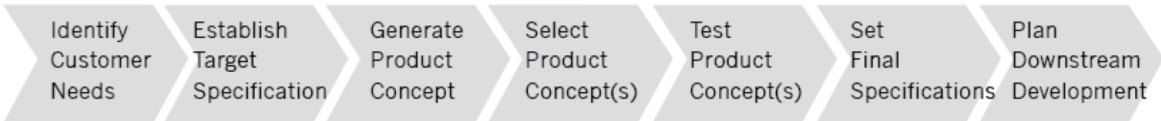


Figure 7. The subactivities of Phase 1; Concept Development (Ulrich & Eppinger, 2007)

The early parts of both the Cooper (1990) and Ulrich and Eppinger (1995) models commonly carry out significant activities to determine the directions of NPD projects to drive idea generation. In Cooper's NPD model, multiple types of core research related to idea generation activities are implemented from 'stage 0' to 'stage 2' (see Figure 4 and Table 4). Many NPD studies that used Cooper's model generally regarded this early part of his model as the idea generation stage (Dahan & Hauser, 2001; Toubia, 2006). In particular, the new product concept is built during this period, which directly affects actual product development after 'gate 3' (see Figure 4).

Ulrich and Eppinger (1995) have suggested a six-phase model (see Figure 5), with detailed secondary stages (see Figures 6 and 7). In comparison to the NPD model of Cooper (1990), the kernel of the idea generation activities is described in 'phase 0' and 'phase1' of their model. The main roles of these phases are identifying the business goal and consumer needs, setting a target, and generating and selecting a product concept (see Table 5).

Front-end

The early part of NPD is normally called the front end (Dahan & Hauser, 2001; Toubia, 2006). Its definition varies among researchers (Aagaard, 2008; Nobelius & Trygg, 2002; Zhang & Doll, 2001). Cooper (1988) defined the front-end phase as the stages including idea generation, initial screening, prior evaluation, and concept evaluation activities, and stated its significance within the NPD process (Aagaard, 2008). Khurana and Rosenthal (1998) described the front end as the activities relevant to product strategy formation, communication, opportunity identification, idea generation, product definition, project planning, and executive reviews. Tatikonda and Rosenthal (2000) defined it as project planning, which includes the selection of projects and ideas to work on, setting up the products, targeting them, and putting in place the key resources and mechanisms to carry out the development effort (Aagaard, 2008, p.4).

The common front-end characteristic from the researchers' descriptions is that it is mostly driven in the early stages of NPD, and it includes multiple key activities related to idea generation.

Significance of the front end within the NPD process

According to Steven and Burley (2003), "the most significant gap between successful and unsuccessful products is the quality of performance in the first few stages of new business development, 'simply stated, the first few plays of the game determine the outcome'" (p.18). A number of innovation process studies showed views that aligned with those of Steven and Burley: an early consideration of their ideas is deeply linked to the success or failure of the final outcomes of NPD (Argument et al.,1998; Bhamra, 2004; Booz-Allen & Hamilton, 1968; Cooper, 1988; MacMillan et al., 2001; Ölundh & Tingstrom, 2008; Poole & Simon,1997; Steven & Burley, 2003). That is because numerous studies of NPD identified that the first investigation to obtain new opportunities for NPD success is implemented in the front-end phase (Christensen et al., 2008; Cooper, 1997, 2001; Kim & Wilemon, 2007; Koen et al., 2001; Murphy & Kumar, 1997; Nobelius & Trygg, 2002).

Due to the important role of the front end in NPD, a significant number of studies about ideas and NPD are exploring how front-end results can be enhanced by systematic idea management (Bailey & Horvitz, 2010; Caughlan & Johnson, 2008; Sandström & Björk, 2010; Selart & Johansen, 2011).

Organisational Learning and Knowledge Management

In both innovative businesses and in product development fields, systematic idea management has been emphasised as a core factor that can lead to the success of innovative projects within the companies (Bailey & Horvitz, 2010; LaValle et al., 2011). LaValle et al. (2011), in a survey of nearly 3,000 people in approximately 30 industries in 100 countries, explored the factors that create obstacles when organisations adopt new ideas in the front-end phase. From the analysis of this survey, they concluded that one of the greatest obstacles is companies' management methodologies when performing idea generation activities.

As fundamental theories for improving systematic idea management, organisational learning (OL) and knowledge management (KM) have been steadily growing in use. They have also attracted attention from both academic study and commercial practice since the 1990s (Cohendet et al., 2017; Easterby-Smith & Lyles, 2011): In real-world NPD projects, companies often wish to promote innovation and business values using OL and KM (Chauvel & Despres, 2002; Earl, 2001; Ives & Combs, 2012). In academic studies, OL and KM are regarded as basic elements that can give innovative value to companies, especially in modern "information and knowledge centred societies" (Castaneda, 2010). In this regard, Smith (2008) stated in his study '*The learning organization turns*' that it is the companies which learn fastest and use knowledge most effectively that tend to be leaders in modern markets (Castaneda, Manrique, & Cuellar, 2018).

Furthermore, for maximising the benefit from the use of OL and KM in the organisations, Carnall (2007) focused on the factor that OL and KM performances are often intermixed (Prugsamatz, 2010; Pun & Nathai-Balkissoon, 2011). Consequently, he emphasised that building convergent systems of OL and KM into companies' vision, culture, and infrastructure is crucial in allowing their innovative business models to succeed.

OL and KM are elementary, factors that are intimately linked to the sustainability and business success of organisations in the current era (Greiner et al., 2007; Jasimuddin, 2008). In the literature review of this study, the existing concepts of OL and KM as leveraged in various studies of innovative business and product development are examined. This review of existing concepts of them has allowed this study to expand fundamental knowledge regarding idea management, and also to identify factors related to improving systematic idea management.

Organisational Learning

Organisational learning (OL) is rated as one of the key ingredients in management and organisational studies (Bapuji & Crossan, 2004). The concept of OL has been studied and defined in various fields and research, and is still debated today (Easterby-Smith & Lyles, 2011; Jain & Moreno, 2015; Wang & Ahmed, 2002). In the 1960s, Cyert and March (1963) introduced the concept of OL in their decision-making research, and they highlighted the process of learning from organisational experience that was particularly related to coping with market environmental changes (Castaneda & Cuellar, 2018). Subsequent to this, the study of OL significantly grew in the 1980s with the study of organisational management, perspective and behavioural learning (Garratt, 1999).

However, several OL concepts and definitions developed through prior studies share a common criticism. As the concept of OL was not firmly established by sufficient consensus between a diversity of organisations and people, its contents, concept and application have become wider and vaguer, thus providing an unclear framework of use to both researchers and practitioners (Cohen, 1991; Miller, 1996; Popper & Lipshitz, 2000; Wang & Ahmed, 2002).

To remedy this problem, a number of researchers (e.g. Castaneda & Cuellar, 2018; Jain & Moreno, 2015; Lorente, Dewhurst & Dale, 1999; Nafei, 2014; Wang & Ahmed, 2002) argued for the necessity of continuous consideration and clarification of an OL concept that can meet current industry requirements. Furthermore, they emphasised the review of existing literature on OL to achieve it.

Castaneda and Cuellar (2018) and Wang and Ahmed (2002) conducted a review of various literature defining OL when related to innovation-led business, and Tamayo-Torres et al. (2016) addressed the OL concepts illustrated in several studies of innovative product development. These three studies of existing definitions of OL all identified “acquisition and creation of knowledge” as the fundamental concept of OL. In addition, three contrasting perspectives on OL concepts were also found in existing literature of innovative business and product development. These three perspectives deal with individual ability, processes or systems, and collaboration culture (see Table 6).

Firstly, the OL concept, which addressed individual competence, focuses on the ability of individual employees to identify and solve problems. According to the researchers who proposed this concept (e.g. Honey & Mumford, 1992; Hyland & Matlay, 1997; Matlay, 2000), individuals (employees) create new knowledge, based on what they have learnt from personal experiences on past projects. This means that the main thrust of OL is individual intellectual exploration of the organisation's performance. In other words, OL focusing on individual ability regards an individual (employee) as the core resource of the organisation, and as an agent who investigates and resolves organisational issues on behalf of the organisation (Argyris & Schon, 1996). This view suggests that the acquisition and creation of knowledge by the individual is significantly related to the business success of wider organisations (Argyris & Schon, 1996).

Conversely, process and system-oriented OL has focused on acquiring and creating institutional forms of knowledge through strategic systems or processes established by the organisation itself (Villamizar & Castaneda, 2014). The studies supporting this OL concept (e.g. Crossan et al., 1994; Cummings & Worley, 2009) adopt the context of the organisation's information processing system as the primary basis of OL (Wang & Ahmed, 2002): the collection, interpretation, and saving of information through an information processing system is the route for acquiring and creating knowledge in such organisations (Huber, 1991). For this reason, organisation-centred leadership (Popper & Lipshitz 2000; Revans, 1982), knowledge integration and institutionalisation of learning (Crossan, Lane, White & Rush, 1994) are referred to as the main elements of OL in such a framework, rather than individual ability.

Thirdly, OL focusing on collaborative cultures within organisations considers both individuals and organisations as key elements for the OL concept. This view of OL (e.g. Bierly, Kessler & Christensen, 2000; Mintzberg, 1994; O'Reilly & Chatman, 1996) generally explains that the vital concept of OL is that an organisation stimulates an individual (staff) to constantly seek new knowledge and share the knowledge with others (Argyris, 1977). This perspective on OL notes the problem of ineffective knowledge creation activities caused by traditional hierarchical cultures (Jones, 1996). Instead, it emphasises building an atmosphere and culture in which individuals can freely utilise their knowledge and experiences, and this latter approach is recommended for achieving the goals of organisations (Bierly, Kessler & Christensen, 2000). According to Drew and Smith (1995), under this framework members of the organisation need to be motivated to implement both individual and group learning. The authors also recommended monitoring the progress of an organisation's learning activity, in order to enhance organisational performance in the long term.

Focus	The Concept of OL	Literature
Individual Ability (Focus on Individual)	Individual's learning capabilities to understand and solve organisational problems	Argyris & Schon, 1996; Burgoyne & Pedler, 1994; Honey & Mumford, 1992; Hyland & Matlay, 1997; Marquardt & Reynolds, 1994; Matlay, 2000; Scarbrough, Swan & Preston, 1998; Senge, 1990
Process or System (Focus on Organisation)	Managing the learning process through systems created by the organisation	Crossan, Lane, White & Rush, 1994; Cummings and Worley, 2009; Glynn et al 1992; Huber, 1991; Pedler, Burgoyne & Boydell, 1991; Popper & Lipshitz, 2000; Revans, 1982; Villamizar & Castaneda, 2014
Collaboration Culture (Focus on Individual + Organisation)	Organisational culture that encourages employees to participate in organisational performance improvement activities through personal learning and team collaboration	Argyris, 1977; Bierly, Kessler & Christensen, 2000; Drew & Smith, 1995; Jones, 1996; Mintzberg, 1994; O'Reilly & Chatman, 1996; Rothberg, 1993; Torbert, 1991; Weick, 1985

Table 6. Synthesised concepts of organisational learning (OL) from review of Castaneda and Cuellar (2018), Tamayo-Torres et al. (2016), and Wang and Ahmed (2002)'s studies

Knowledge Management

Knowledge management (KM) is a concept developed simultaneously with OL in the new economy, and both concepts are frequently interconnected in both their definitions and applications (Wang & Ahmed, 2002). The conceptualisation of KM has been actively explored since the 1990s, when the demand for knowledge-intensive industry arose due to the accelerated development of information technology (Alavi & Denford, 2001; Castaneda & Cuellar, 2018).

KM has often been considered as an increasingly critical discipline. It can boost the generation, sharing and leveraging of organisational knowledge. Many aspects of KM research have taken the knowledge economy theory of Peter Drucker, a great proponent of KM, as the basis for the concept of KM (Becerra-Fernandez & Sabherwal, 2014). His famous paper *The age of social transformation* (1994) provided a clear explanation of the need for organisational KM in modern information and knowledge-rich society.

Knowledge has become the key resource, for a nation's military strength as well as for its economic strength... Knowledge as the key resource is fundamentally different from the traditional key resources of the economist - land, labor, and even capital… That knowledge has become the key resource means that there is a world economy, and that the world economy, rather than the national economy, is in control… We need systematic work on the quality of knowledge and the productivity of knowledge (Drucker, 1994, p.16-19).

The key concept of KM is to increase the competitiveness of organisations by creating a way to efficiently use knowledge that the company already possesses or can acquire (Becerra-Fernandez & Sabherwal, 2014; Donate & Pablo, 2015; Grant, 2002). KM is based on the concept of intellectual capital. The intellectual capital of an organisation includes the total knowledge resources that an organisation can acquire or generate, from both outside and inside of the organisation itself (Nahapiet & Ghoshal 1998). Becerra-Fernandez and Sabherwal (2014) noted three distinct types of organisational intellectual capital, which are similar to the concepts found in OL:

…human capital, or the knowledge, skills, and capabilities possessed by individual employees; organizational capital, or the institutionalized knowledge and codified experience residing in databases, manuals, culture, systems, structures, and processes; and social capital, or the knowledge embedded in relationships and interactions among individuals. (Subramaniam & Youndt, 2005, p.5)

In addition, KM research emphasises the study of efficient and systematic methods of developing, maintaining, and transferring knowledge (i.e. the need for management to move beyond merely generating organisational knowledge) (Alavi & Leidner, 2001; Grant, 2002). According to Drucker (1999), the vital factor to be considered in the development of the KM system is to make the knowledge 'productive' in real practice, rather than simply creating tools and procedures for knowledge development and sharing. In technology-intensive industries that rely on the development of new products or processes, KM's primary purpose is to support product innovation in their products through the application of knowledge (Nonaka & Takeuchi, 1995; Raisch & Birkinshaw, 2008; Subramaniam & Youndt, 2005). In this case, KM might perform in the format of the idea management system, which stimulates employees to create ideas and share these ideas with other people in the organisation (Cohendet et al., 2017; Pluskowski, 2002). This implies that KM performs a social function that assists knowledge sharing and communication (Drucker, 1999). The mutual knowledge flow among employees inspired by this approach can bring innovative results to the organisation (Alavi & Leidner, 2001; Liebowitz, 2005; Pluskowski, 2002).

In summary, OL and KM are keys to determining the success of organisations in today's knowledge-based society. This is especially true for organisations that develop new products, as these require a KM system that enables efficient knowledge transfer, which helps them to achieve business innovation.

Systematic idea management

Idea management is a strategy to achieve the organisational creativity that is necessary for the success of innovation (Bassett-Jones, 2005; Cohendet et al., 2017). Idea management is mostly framed by the KM system (Cohendet et al., 2017; Pluskowski, 2002). Idea management has no generally accepted definition in innovation management studies (Brem, 2008). It frequently displays a positive relationship with levels of creativity and quality of ideas when these are measured (Clark, 1980; Kijkuit et al., 2007). Idea management has been described as a strategic tactic for new company projects as a sub-process of innovation management (Brem & Voigt, 2007), and it is generally related to staff cognition, creativity, and interaction with customers when generating new ideas (Jensen, 2012; Westerski *et al*., 2011).

To enhance the effectiveness of idea management in NPD, as with OL and KM research, studies of the idea generation process consistently emphasise the need for systematic methodologies. Pugh (1991) and Hubbard (2010) highlighted the lack of a systematic methodology in the idea generation phase as the reason for difficulties in applying research results in real-world practice in a new product process. Warren et al. (2009) agreed on the effectiveness of systematic NPD management for improving the likelihood of predicting the final results. Ries (2011) also concurred on the importance of systematic management for enterprises, combining analytical techniques and practical expertise. Hatchuel et al. (2010) addressed the link between creativity and systematic knowledge management. In a study that set out to discover the correlation between employees' freedom and effective management when generating and developing ideas, Amabile (1998) found that providing a clear, systematic path was important in helping to improve staff creativity in organisations. Although Amabile (1998) found employee freedom to be an important factor in creating ideas, he stated that it can be meaningless if companies fail to give them a systematic direction.

Some studies of systematic management regarding ‘how the system can be blended into an organisation’s procedure’ investigated methods of establishing an effective system. Foucault (2000) and Hatchuel et al. (2010) discussed whether the established system reflects real practice results or not; for without considering actual outcomes, the system may not progress and thus may come to a standstill. Leavy (2010) advocated that methods should attempt to harmonise exploration and exploitation to develop efficient systems, which is consistent with the point of Martin (2010). In addition, according to March (1991), a system that pays attention to exploration without exploitation might take an unreasonable approach to its projects; it may spend resources such as money and time without any potential benefit. In contrast, systems that seek exploitation without exploration can be perceived as incomplete. As a result, keeping a pertinent balance of exploration and exploitation is an essential stepping-stone to building an effective and successful system (Leavy, 2010; March, 1991; Martin, 2010).

Uncertainty in Cross-functional NPD

In studies investigating uncertainty within NPD, it has normally been defined as a climate in which it is difficult for information to reflect market or technological change promptly, or to forecast future circumstances (MacCormack, Verganti, & Lansiti, 2001; Spender, 1993). Previous studies have mentioned that external uncertainty such as market change is a main factor affecting the NPD process (Cross, 2001; Hatchuel et al., 2010), and a number of scholars have attempted to discover effective ways to measure and manage the external uncertainty in the NPD process using systematic models (Oh et al., 2012). While a number of previous studies investigated how to manage external factors that affect uncertainty effectively, some research has focused more on internal issues. Specifically, they looked at the relationship between cross-functional tasks and uncertainty in NPD (Sarin & McDermott, 2003; Thamhain, 1983). Sarin & McDermott (2003) explained the importance of cross-functional tasks for reducing uncertainty in the NPD process: cross-functional staff members can present knowledge and information from different backgrounds and expertise to approach the common aim of NPD. Also, many studies on cross-functional tasks have identified the importance of enabling staff members to comprehend their influence on and commitment to NPD, since a lack of thinking responsibly can potentially be a major obstacle to dealing successfully with uncertainty within cross-functional works (Hardaker & Ward, 1987; Sarin & McDermott, 2003; Thamhain & Wilemon, 1988).

Risk Management and Uncertainty

Risk and the management of risk are often referred to in studies of uncertainty, and prior research has reported that decreasing the fear of risk in employees can bring about a reduction of uncertainty and the achievement of innovative outcomes (e.g. Amabile, 1988; Gupta, Raj, & Wilemon, 1986; Saleh & Wang, 1993; Sethi et al., 2001; Van de Ven, 1986).

Saleh et al. (1993) addressed the need for companies to create an atmosphere in which staff members would not hesitate to employ a new approach in their work, even though they may be taking a risk. Also, several papers described that taking risks and giving opportunities to employees to take challenges is crucial for engendering innovative ideas in firms (Amabile, 1988; Gupta, Raj, & Wilemon, 1986). However, several previous NPD studies found that, although companies recognise the benefit of a climate where people are not afraid of taking a risk in their new challenge, companies tend to discourage employees involved in NPD projects from applying novel methodologies or ground-breaking ideas (Cyert & March, 1963; Van de Ven, 1986). In this regard, a number of scholars noted that building a company culture that motivates employees to assume the risk of carrying on with new challenges is valuable for reducing uncertainty and achieving innovative outcomes (e.g. Amabile, 1988; Cyert & March, 1963; Saleh et al., 1993; Sethi et al., 2001; Van de Ven, 1986).

2.2.2. Benefits of a Multidisciplinary Approach

Knowledge Sharing and Multidisciplinary Thinking

Effective internal communication among the staff of companies has been identified as an important factor in facilitating innovative NPD and enabling multidisciplinary ideas (Holloway, 2009; Negroponte, 2003; Verganti, 2003). According to Holloway

(2009), there are many ways that internal communication can generate novel insights during the generation of ideas, as ideas can be built up by combining diverse paradigms and the blended opinions of people with various functions.

Negroponte (2003) stated the advantage of synthesised thinking from a wide spectrum of experiences. Mixed thinking usually encourages people to use multiple ways to find answers using various types of knowledge rather than relying on the conventional way to find solutions. He also described that people who try to explore an innovative approach frequently display multidisciplinary minds and embrace a large spectrum of backgrounds to seek breakthrough ideas. Such boundary crossers often pursue numerous alternatives and attempt to mix solutions instead of choosing one-sided answers (Negroponte, 2003; Pink, 2006). They avoid selecting only one answer, but instead try to search for multiple ways or blended solutions.

Many companies not only emphasise the attention given to the consumer's voice between by external communication, but they also request internal communication between different kinds of people or teams to spread and share consumer needs effectively (Gresham et al., 2006; Jacobsen et al., 2014; Kohli & Jaworski, 1990).

Enabling employees to see the bigger picture of a whole project journey through sharing information is a crucial part of the NPD process (Pink, 2006; Warren & Fuller, 2009), as NPD is essentially a knowledge-based activity (Lawson et al., 2009). However, companies have faced difficulties in sharing knowledge between people carrying out diverse functions in the NPD process (Lawson et al., 2009), although they have been aware of the importance of knowledge sharing through internal communication (Van Den Hooff & De Ridder, 2004).

It has long been recognised that establishing multidisciplinary teams during idea generation phases helps to incorporate diversity of knowledge and paradigms from each function, often resulting in the gaining of extraordinary insights (Holloway, 2009). Studies on the multidisciplinary or cross-functional teams of NPD illustrated a potent advantage of the synthesised and balanced ideas developed by compounded knowledge (e.g. Brown, 2008; Hatchuel et al., 2010; Jansen & Goldsworthy, 1995; Negroponte, 2003; Nissani, 1997). Jansen and Goldsworthy (1995) and Nissani (1997) stated that multidisciplinary methodologies can link different disciplines; therefore, this approach contributes to reducing the gap between the way different types of people think. It also helps individual creators to combine diverse ideas easily, using a wider spectrum of knowledge from various specialised studies. This consequently helps to produce integrated outcomes that surpass the individual experts' knowledge. According to Vissers et al. (2002), integrative R&D teams play a key role in business enterprises; the more interdisciplinary the R&D teams, the better the company will be able to identify professional information. By using various angles of observation, multidisciplinary organisations can also interpret and judge product quality and consumer needs more professionally when developing new ideas (Vissers et al., 2002). Multidisciplinary teams help improve the quality of new ideas by joint development activities among the holders of specialised knowledge (Jansen & Goldsworthy, 1995; Negroponte, 2003; Nissani, 1997; Vissers et al., 2002). However, Vissers et al. (2002) identified low numbers of multidisciplinary R&D teams in their study. Companies tend to focus on involving a limited number of employees in fields directly relevant to the key activities in NPD (Vissers et al., 2002).

Pattern Recognition

New product systems and processes are often implemented in uncertain environments, which require consideration of all possible contingencies and unpredictable futures (Sarasvathy, 2001). Furthermore, fast-moving technological and industrial standards often bring complexity and non-linear methods into an organisation's business (Garnsy & Heffernan, 2005). For this reason, more and more firms are making efforts to control and react to these unstable market changes (Warren & Fuller, 2009), and they often face major challenges in acquiring new insights within these circumstances. Williams (2010) stated that these kinds of insights do not come from looking at the obvious factors only; they derive from completely unexpected areas or resources as well. He illustrated that people in organisations might be asked to seek insights and discover meanings from both obvious and non-obvious areas. In other words, employees are required to interpret emergent patterns that they identify in obvious and non-obvious sources, based on integrated analytic knowledge (Williams, 2010). Pink (2006) has emphasised the importance of 'pattern recognition' and defining it as 'understanding the relationships between relationships'. He defines this capability to synthesise as:

> *Seeing the big picture, crossing boundaries, and being able to combine disparate pieces into an arresting new whole. (Pink, 2006, p. 66)*

Pattern recognition is regarded as a key requirement for decision-makers. Daniel Goleman (1998) investigated the link between 'decision-makers' insight' and 'pattern recognition' in his study of executives at several large companies, and found the value of the latter (Warren & Fuller, 2009). According to Goleman's results (1998), "Just one cognitive ability distinguished star performers from average: pattern recognition, the 'big picture' thinking that allows leaders to pick out the meaningful trends from the welter of information around them and to think strategically far into the future" (Goleman, 1998, p.33).

However important it is to have this capability in a leader, it has been recognised that pattern recognition skills are helpful for all employees. Enabling more staff members to see the big picture of their projects is advantageous in that it helps them to carry out a distinguished performance within their knowledge-based projects and complicated environments (Lawson et al., 2009; Pink, 2006; Reid & De Brentani, 2004; Warren & Fuller, 2009).

Employee Involvement

It is understood that NPD processes typically deal with various issues in many kinds of fields, such as changes in technology, consumer needs, market trends, competitors, and regulation (Ruekert et al., 1987; Song et al., 1998). Because of dependencies created between the different kinds of fields (Song et al., 1998), the need to engage with multiple interrelated factors and issues can lead to uncertainty and complexity. A number of studies have examined the benefit of multidisciplinary teams and cross-functional tasks for improving the NPD process of firms, thus identifying the importance of cooperation between various functions for companies to achieve successful outcomes (Griffin et al., 1992, 1996; Parry et al., 1993; Song et al., 1998; Souder, 1977).

Several studies have verified empirical results on the usefulness of cross-functional performance in NPD. In examining the relationships between marketing and R&D during the NPD journey, Hise et al. (1990) concluded that integration between the research and development departments is a significant tactic in the success of NPD (Song, Thieme, & Xie, 1998). Moenaert et al. (1995) have discovered that cross-functional works are more effective when they are implemented in the planning stages rather than the development stages of NPD. This is because minimising teams' uncertainty through cooperation in the planning stages facilitates more opportunities for successful innovation outcomes (Song, Thieme, & Xie, 1998).

According to Souder (1987), success is attributed to the early involvement of all functions that enables team members to better trust each other through the gradual sharing of ideas and being able to understand and recognise a member's contribution to the project development, which typically leads to the saving of development time and improved quality of the products (Griffin et al., 1996). The different perspectives between different types of teams in cross-functional tasks enables them to check each other's thinking during the development of ideas, which is a determinant of successful NPD (Sethi & Park, 2001). In addition, this different perspective contributes to identifying new linkages between varying types of knowledge (Milleiken & Martins 1996; Osborn, 1963).

Research has established concerns about the side effect of integrating diverse perspectives, as it is suggested that it can create information overload within teams (Olson, Walker, & Ruckert 1995). Also, a complicated or untidy cooperation process might interfere with discovering a meaningful connection between various types of knowledge (Amabile, 1983; Sethi et al., 2001). To avoid this side effect, simple and systematic structures for collaborative processes are required (Andrews & Smith, 1996; Van de Ven, 1986).

Maltz and Kohli (1996) established that cross-functional tasks can fail if the members face pressures from interdepartmental rivalry and political manoeuvring (Friedkin & Simpson, 1985; Maltz & Kohli, 1996; Ruckert & Walker, 1987). According to Maltz and Kohli (1996), the problem arises from linked people in each function tending to ignore or refuse the information, views, or opinions from other functions. This breakdown affects the teams' ability to see synthesised outcomes – particularly those linked to valuable connections encompassing consumer needs, new technology, and the company's capacity issues. This scenario has a direct impact on idea generation activities. This problem is often related to teams and team members trying to maintain their own functional identities and stereotypes (Jaworski et al., 1993; Slater & Narver, 1995). Sethi et al. (2001) have determined the influence of the level of psychological bond between employees on the success of cross-functional works. They discovered that the integration of different functional perspectives is more efficient when employees feel they are deeply involved in projects and have a strong psychological ownership of them, which encourages cooperative performance and motivation (Deshpande & Zaltman, 1982; Pierce, Rubenfeld, & Morgan, 1991).

Enhancing employees’ engagement in projects is recommended as the way to improve staff members’ quality of performance and results (Abrashoff, 2007; Buckingham & Clifton, 2001). Abrashoff (2007) illustrated that a vital factor for achieving business success is making employees proud of their work. Gallup (2008) also mentioned that a higher level of employee involvement can bring about upgraded business results. Gallup’s (2013) research about employees’ engagement in business indicated that companies who have a higher score of employee involvement in business have shown greater possibilities of business success than other companies with lower scores. In other words, increasing the level of employee involvement in projects and giving them ownership of projects might be a strategic way to achieve business success (MS-ECE et al., 2014).

Many studies about employee involvement have focused on empirical and strategic tactics for cross-functional tasks (Olson et al., 1995; Song et al.,1998; Wheelwright et al.,1992). For example, Song et al. (1998) investigated whether different kinds of functions need to be involved in every NPD stage or not, as “blindly promoting the involvement of all functional areas in all stages of the NPD process may actually decrease NPD performance” (p.289). They found that adjusting proper levels of joint involvement and finding the right mix of cross-functional teams are potentially better tactics to building an effective NPD process, and that the levels and kinds of mixed teams can be changed, depending on the NPD stage.

2.2.3. Mistrust in the Internal Relationship

Mistrust and Lack of Trust

Trust is regarded as an essential factor in the creation of effective relationships in cross-functional tasks, especially in terms of developing cognitive and affective cooperation across interacting departments (Newstrom, 2011; Smith et al., 2017).

In this regard, several studies in NPD (Dayan et al., 2009; Griffin et al., 1996; Seabright et al., 1992; Song et al., 1998) have addressed the level of trust during cross-functional NPD processes, and these have reported on the implications of the latter for NPD outcomes. According to their reports, trust among interdependent individuals or teams within an organisation helps to harmonise actions and improve the effectiveness of NPD activity; also, mistrust typically appears to make individuals less willing to agree with opinions of others from connected groups. A common and agreed meaning for trust (and related concepts such as ‘mistrust’) is something that is still lacking in research: this is linked to the fact that the term trust can be defined in multiple different ways depending on the purpose of the study at hand (Levi, 1998). For this reason, research that connects with issues of trust and its corollaries research about trust needs is required to clarify the concept/term in order to avoid the potential for confusion among scholars and research users (Levi, 1998).

This section will critically examine the impact of mistrust in the context of NPD. Specifically, and as further outlined below, it is important to evaluate whether the terms 'lack of trust' and 'mistrust' can be interpreted as having an identical meaning. There are two parallel views in defining ‘lack of trust’ and ‘mistrust’ in academic research regarding the concept of ‘trust’: 1) mistrust is the opposite meaning of trust, therefore the lack of trust is the same meaning as mistrust, 2) mistrust is not the opposite meaning of trust, therefore the lack of trust is not the same meaning of mistrust.

Several researchers in the social sciences that focus on levels of trust in organisational culture and activities use the term ‘mistrust’ as a synonym for ‘lack of trust’, as they argue that trust and mistrust are the opposite poles in the same continuum (McKnight & Chervany, 2001; Schoorman et al, 2007) (see Figure 8).

For instance, Schoorman et al (2007) assert in their paper *An integrative model of organizational trust* that they regard the lack of trust to have the same definition as mistrust or distrust. Their choice of this view is obtained from the various typical dictionary definitions of mistrust and distrust; Webster’s defines distrust as “the lack or absence of trust” and Random House as “to have no trust in”. From a sociological perspective, Ross, Mirowski, and Pribesh define mistrust as the “absence of faith in other people” (2001) (Schoorman et al, 2007, p. 350).

In addition, some recent studies in the field of collaborative tasks and knowledge sharing in NPD have regarded the meaning of lack of trust and mistrust as being equal, and have investigated how to either raise the level of trust or lower the level of mistrust in order to improve an organisation’s performance in cooperative work (Buvik et al., 2015; Zaglago et al., 2016). In Buvik et al.’s paper *Prior ties and trust development in project teams* (2015), both the terms ‘lack of trust’ and ‘mistrust’ are used interchangeably when describing issues of information sharing. The authors point out that ‘a lack of trust’ in a relationship was the main cause of a lack of full or open information sharing. In a more detailed exposition of the point, they argue that the level of restricted information is linked to the level of mutual ‘mistrust’ amongst teams or individuals: this is reinforced from the continuous disconfirming behaviour with regard to each other in the past. Ribiere and Sitar (2003) and Bell DeTienne et al.’s (2004) studies of the impact of mistrust on fostering a knowledge-sharing culture have taken the same view of the terms trust and mistrust. They emphasise creation of an organisational environment in which multiple departments in an organisation have trust in other parties' opinions or abilities, and where mistrust or lack of trust do not exist. Also, Zaglago et al. (2016) alternatively used the terms ‘lack of trust’ and ‘mistrust’ in a paper entitled *Barriers to a knowledge-sharing culture among design teams*. They perceive that lack of trust or mistrust are both direct and literal opposites of trust when taking a measurement of the level of trust. According to them, full trust is an essential element in sharing knowledge, and lack of trust or mistrust can lead to a reluctance to share.

These studies, which suggest that mistrust and trust are opposite concepts on the same spectrum, commonly focus on the correlation between the level of trust of organisational members (in terms of other party’s opinions, data, and abilities) and the outcomes of organisational activities through measuring the level of trust.

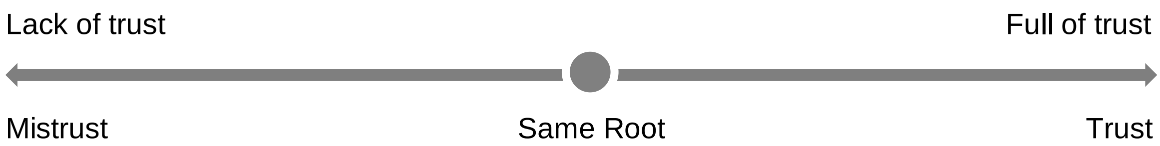


Figure 8. Concepts of mistrust and trust: the opposite conclusions from the same continuum

In contrast, some studies of trust and mistrust in social relationships contend that the terms ‘lack of trust’ and ‘mistrust’ have different meanings. These studies consider ‘trust’ and ‘mistrust’ as separate concepts, therefore the terms do not sit at opposite ends of the same continuum (Babbie, 2011; Lewicki et al., 1998; Sparks et al., 2016).

Lewicki et al. (1998) have investigated relationships between trust and mistrust in social realities. According to them, the meanings of trust and mistrust are not polar opposites: consequently, low trust and high mistrust can coexist. They also believed that trust is more related to the dimensions of level of hope, faith, confidence, assurance, and initiative, while mistrust is more characterised by level of fear, scepticism, cynicism, wariness and watchfulness, and vigilance (see Figure 9). For example, in cell 4, a high level of trust and high level of mistrust can coexist in a case where two highly bounded parties in a collaborative task have the same goals but also separate objectives; both organisations or departments might have a high level of confidence in the other party's capacity for success and delivery of results, but at the same time they maintain a high level of watchfulness over each other to avoid loss of advantage/benefit compared to the other party (Lewicki et al., 1998). In Lewicki et al. (1998), although trust and mistrust are regarded as separate concepts, cells 1 and 3 show a similar pattern to that implied by the alternative theory (i.e. that trust and mistrust are opposite positions on a single continuum) (see Figures 8 and 9).

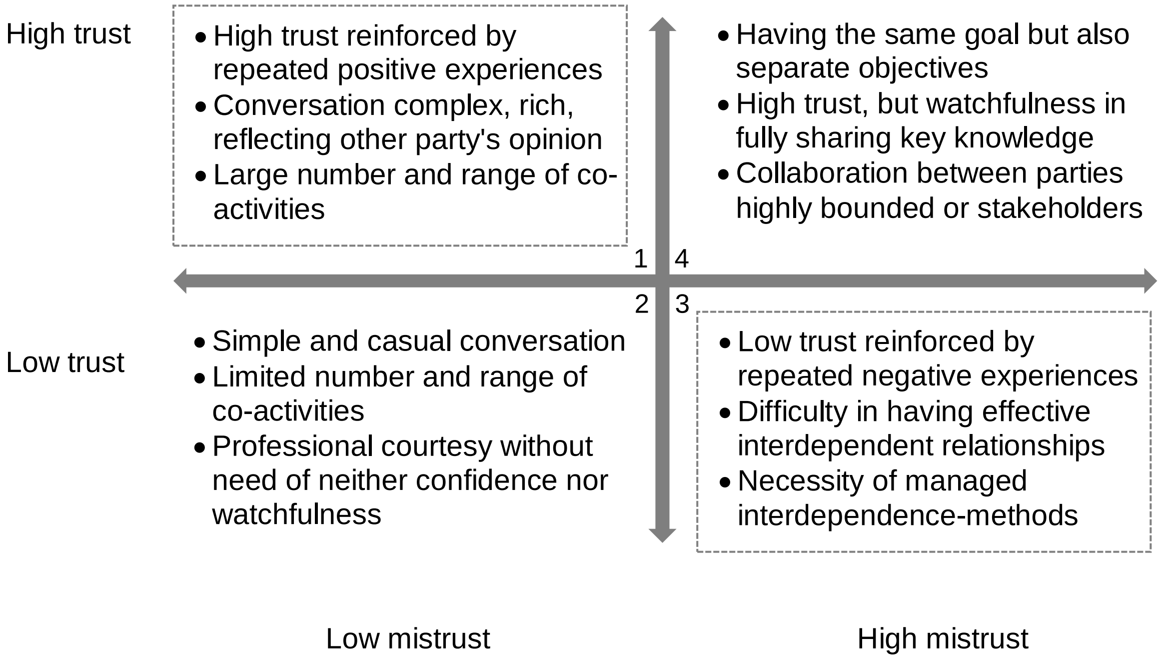


Figure 9. Main characteristics of coexisting mistrust and trust (Lewicki et al, 1998)

The main purpose of this research is to identify the factors that can potentially aid in eroding or eradicating mistrust when knowledge and information are shared between different functional teams in MNEs. Also, this study concentrates on the relationships between different functional teams in the same organisation, an environment which encourages full knowledge sharing across teams as opposed to watchfulness with respect to key resources. With regard to this purpose, multiple concepts relevant to the study are identified in both the 'poles'/continuum theory (see Figure 8) and in characteristics in cells 1 and 3 of Lewicki et al. (1998) configuration (see Figure 9). However, this study could not find significant relationships in characters in cells 2 and 4 in the later theory (see Figure 9).

From a comparison of the two parallel theory-based positions regarding the relationship between ‘trust’ and ‘mistrust’ in the literature, therefore, this study adopted the more typically used definition of mistrust (i.e. that trust and mistrust are opposing positions on a single continuum). So, for the purposes of this study, ‘lack of trust’ and ‘mistrust’ are perceived to have the same meaning (Buvik et al., 2015; McKnight & Chervany, 2001; Schoorman et al., 2007; Webster, 2001; Zaglago et al., 2016).

Internal Conflicts

NPD is commonly completed with the cooperation of multiple staff members who mutually depend on each other (Xie & Song et al., 1998). However, the cooperative works might be challenging, due to the different ways of thinking, language, and work journeys among the multiple members (Lam & Chin, 2005). For this reason, several studies in NPD have addressed the conflict between various kinds of people in organisations, and they discovered that internal conflicts do affect the results of NPD (Chan, 1989; Dyer & Song, 1998; Gobeli et al., 1998; Pelled & Adler, 1994). In addition, a number of studies about interpersonal trust within NPD works (Cook & Wall, 1980; Dayan et al., 2009; Rempel et al., 1985) showed that reducing or eliminating conflicts between different levels or types of people may contribute to achieving the companies’ business success (Kim, 2017).

According to Lam and Chin (2005), a large number of studies on conflict management in NPD have concentrated on finding the sources or factors that generate conflicts, and have investigated the connection between the level of conflict and management styles in reducing the difference (Chan, 1989; Gobeli et al., 1998; Kezsbom, 1992; Xie et al., 1998). However, it has been pointed out that the conflicts emerging during the process of applying analytical elements to real practice need to be studied further (Lam & Chin, 2005).

Rahim (1986) argued that conflicts have resulted in advantages and disadvantages. The conflicts between different types of people can stimulate innovation, creativity, and better decision-making, while dissatisfaction and difficulties in relationships are shown as a side effect of that. The gaps in the viewpoints among various teams or team members can be used successfully when projects aim at recognising different aspects in order to seek a best-case solution within functional and/or task-oriented environments (Amason, 1996; Jehn, 1997; Priem & Price, 1991; Putnam, 1994; Sessa, 1996; Tjosvold, 1985). Amason (1996) illustrated that this kind of dispute can contribute to improving decision-making, since the synthesised opinions from diverse views of issues generally surpass one-sided views. Variety in evaluations of the results by different experts may accelerate the creation of valuable solutions (Hoffman, Harburg, & Maier, 1962).

Several studies have revealed that internal conflict is usually classified into two types of categories: (1) reasons (i.e. task vs. emotion) or (2) scale (i.e. individual vs. group) (Blake & Mouton, 1984; Guetzkow & Gyr, 1954; Pelled et al., 1994; Rahim, 1986; Ross, 1989).

(1) **Task vs. Emotion Conflicts**

In 1994, Pelled and Adler described how task conflict emerges from contrasting views when different people or groups are involved in the same work, while emotional conflict occurs from feelings of dislike or hostility. Ross (1989) previously described the correlation between task-centred and emotion-centred conflict. According to him, arguments in the task may bring emotional conflict, since people often feel some hostility towards opponents in cases where the project participants have a serious disagreement about opinions on the task. Ross (1989) explained that, conversely, emotional conflicts might impact task conflict as well.

(2) **Individual vs. Group Conflicts**

Rahim's publication *Managing conflict in organisations* (1986) defined conflicts in organisations as "disagreements, differences, or incompatibilities between the members or their representatives of two or more groups" (p. 1201). Blake and Mouton (2013) more recently highlighted that, when conflicts emerge within interpersonal spaces, an individual has the chance to react or change their opinion promptly, depending on which new data they get; whereas, in intergroup conflicts, members of the group are limited in their chances according to the team's regulations. This research showed that internal conflicts are normally affected by how much understanding and anxiety exist in regard to their projects (Pelled & Adler, 1994; Rahim, 1986).

Different Language and Mistrust

The cooperation among various teams and the interface between marketing and R&D are generally regarded as critical elements of successful NPD processes (Griffin et al., 1996; Gupta et al., 1985; Leenders & Wierenga, 2002; Song et al., 1998). However, achieving a synthesis of different ideas from a variety of expert groups is not easy because of the gap between different types of teams in terms of aspiration, needs, cultures of thinking and language, and responsibilities (see Table 7) (Griffin & Hauser, 1996; Gupta et al., 1985; Leenders & Wierenga, 2002). Griffin and Hauser (1996) considered that a subtle gap in language often results in misleading explanations and misunderstandings, and it might bring unsuccessful results for a project. This communication breakdown can cause members to become demoralised in collaborative works (Griffin, 1992). Although a variety of knowledge from different fields is required in innovative works, team members and/or teams on collaborative projects might be unwilling to agree with the opinions of other functional teams, as they might mistrust different ideas during communication with them (Becker, 1975; Van Der Vegt & Bunderson, 2005).

Furthermore, the gap between marketing and R&D can also create a delay in launching new products, cause budget overflow, and create fewer benefits in comparison with previous products (Leenders & Wierenga, 2002). The barriers among different functions often emerge from collectivistic tendencies, such as behaviour to preserve self-identity or a group culture in collaborative works (Jaworski et al., 1993; Leung,1988; Slater & Narver 1995; White et al., 2008). Repetitive experience of the barrier between different teams may also strengthen their typical traits (Dougherty, 1992). Collectivistic cultures and values have a potential negative effect on NPD performance and results (Earley & Gibson, 1998; Gibson, 1999).

	Marketing	R&D
Aspiration (Saxberg & Slocum, 1968)	• Organisational survival and growth • All activities relevant to firm's objectives • Organisational recognition	• Knowledge as a source of value to humankind • Research for research's sake • Peer evaluation and recognition
Needs (Saxberg & Slocum, 1968)	• Plans, procedures, policies, rules • Organisational recognition • Teamwork • Increased organisational status	• Autonomy • Peer recognition, creative environment • Continuing education and development • Support for advancing knowledge in society
Cultural Thought And Language (Griffin & Hauser, 1996)	• General problem solving for profitable corporate performance • High tolerance for ambiguity and bureaucracy • A loyalty to the firm • Product benefits • Perceptual positions	• Testing and solving technical problems using hypotheses • Low tolerance for ambiguity and bureaucracy • A loyalty to own profession • Specifications • Actual performance

Responsibilities (Dougherty,1992; Souder et al., 1993)	• Different priorities (planning stage) depending on the stage at which they are involved	• Different priorities (developing stage) depending on the stage in which they are involved

Table 7. General trends of marketing/R&D traits (Griffin & Hauser, 1996, p.196-197)

A number of studies on the relationship between internal trust and innovation outcomes have described how building trust among people responsible for different types of functions may bring effective NPD performance for innovative outcomes. According to Rousseau et al. (1998), in a flexible and decentralised working environment such as NPD a high degree of trust can enable members to contribute to collaborative works, because trust among interdependent people or teams within an organisation helps to harmonise each other's actions and improve the effectiveness of NPD works (Pennings & Woiceshyn, 1987; Seabright et al., 1992). Morgan and Hunt (1994) also explained that trust might be used significantly to reconcile one-sided thinking with that of another.

Several studies have illustrated that people who believe that other staff in different functions are competent and reliable on projects (Massey et al., 2007) are more willing to cooperate in informal works; as a result, efficient processes can be built by reducing or simplifying unnecessary procedures based on each other's beliefs (Williams, 2001).

In addition, McAllister (1995) discovered that colleagues who have a solid trust in each other are more attentive to each other's needs in their work. This means that trust may cause people to develop a greater interest in their colleagues' needs, thus allowing them to consider their peers' requests positively (Clark et al., 1989) and to aid them in achieving their goals (McAllister, 1995).

In contrast, when there is mistrust in relationships, people can act uncooperatively in order to defend themselves from the influence of untrustworthy colleagues (Massey et al., 2007). This can cause unnecessary work or processes, such as duplicating support resources, lack of productive communication, and excessively formalised structures for collaboration (Ashforth & Lee, 1990; McAllister, 1995).

Therefore, it is necessary for companies to create structures that reduce language barriers between different functional teams. These can contribute to decreasing or eliminating mistrust among their members, thus supporting efficient NPD processes.

Integrating Different Types of Expert Groups

Early studies of interaction over departments illustrated that efficient integration of different disciplines could be achieved when a formal process managing the integration interface between each functional team is applied to the project (Gupta, 1988). Subsequent literature on interdepartmental integration research placed emphasis on examining a strategic methodology to reduce the gap among different functional teams. Griffin and Hauser's seminal paper entitled *Integrating R&D and marketing: a review and analysis of the literature* (1996) classified and introduced the basic NPD process structures and tools generally used by many large companies (see Table 8), which are still widely used as a basis of cross-functional working process in NPD studies (Dahan & Hauser 2001; Ekerå et al., 2015; Toubia, 2006).

Types		Methods
Organisational Structure	Coordinating Groups (Lorsch et al., 1965; Souder,1988)	• Special group with a balanced knowledge of various functional perspectives resolves diverse opinions between different functions and monitors NPD progress.
	Matrix Organisations (Cannon-Bowers et al., 1992; Tornatzky et al., 1990)	• Functional experts reside in their team and participate in projects when their expertise is needed. • Balancing the time distribution between functional groups and projects is important.
	Project Teams (Griffin, 1993; Rochford et al., 1992;)	• As a temporary group, result is usually better when projects are short term. • Superior performance is usually shown in short-term projects or when technology changes are not fast. • Since the members are completely separated from their functional teams during the project, the longer the project period, the fewer chances for employees to improve their expertise.
Formal Integrative Management	Phase-Review Processes (Hayes et al., 1996; Rosenau, 1988)	• At the end of each phase of the NPD process, the results are reviewed by directors, and decisions are made by them to move to the next stage or stay. • Teams involved in the project are different depending on phase. • Employees dealing with the latter part of NPD have little time to get project details.
	Stage-Gate Processes (Cooper, 1990)	• Similar to Phase-Review Processes, but multiple functions are handled in one phase.
	PACE: Product and Cycle-time Excellence (McGrath et al., 1992)	• Coordinating Group as a centralised organisation builds, conducts, and maintains a structured Phase-Review Process for functions in a company. • Seven interrelated elements to ensure project success and minimize time-to-market: 1) a gated NPD process, 2) a small cross-functional Core Team empowered to make all decisions about the project, 3) a structured development process that ensures consistency, and 4) efficient use of development tools and techniques, 5) a Product Strategy Process that provides a framework for product development

		decisions, 6) comprehensive technology management, and 7) pipeline management which provides a framework for project prioritization, cross-project resource management and aligns functional capabilities and project requirements (planisware, 2018, para. 2).
	QFD: Quality Function Deployment (Griffin, 1992; Kobe Shipyard, 1972)	• QFD provides a translation mechanism using HOQ (House of Quality) from languages of customer (marketing) to engineer, to avoid misunderstandings and to ask each function to elucidate their own thought world.

Table 8. Strategic methods for integrating different teams (Griffin & Hauser, 1996)

For the last decade, a number of researchers have been investigating new methodologies of interdepartmental integration to reduce barriers by developing existing models (e.g. Cooper & Edgett, 2006; Trott, 2012; Ulrich & Eppinger, 2007). Ulrich and Eppinger (2007) focused on subdivided practical activities for NPD, developing models with suggestions for the role of each function accordingly. In addition, Ulrich and Eppinger's model can be complemented by Cooper's stage-gate process (Ekerå et al., 2015), one of the most acknowledged NPD models (Trott, 2012). This model is expected to assist greatly in the elimination of barriers between different functional departments and to build effective integration of NPD processes from both macroscopic and microscopic viewpoints (Ekerå et al., 2015). Trott's network model (2012), a recent contribution to the NPD study (Ekerå et al., 2015), concentrated on the accumulation of knowledge from external experts to strengthen internal integration and to create innovative products (see Figure 10). The concept of this approach is that it utilises external resource's input.

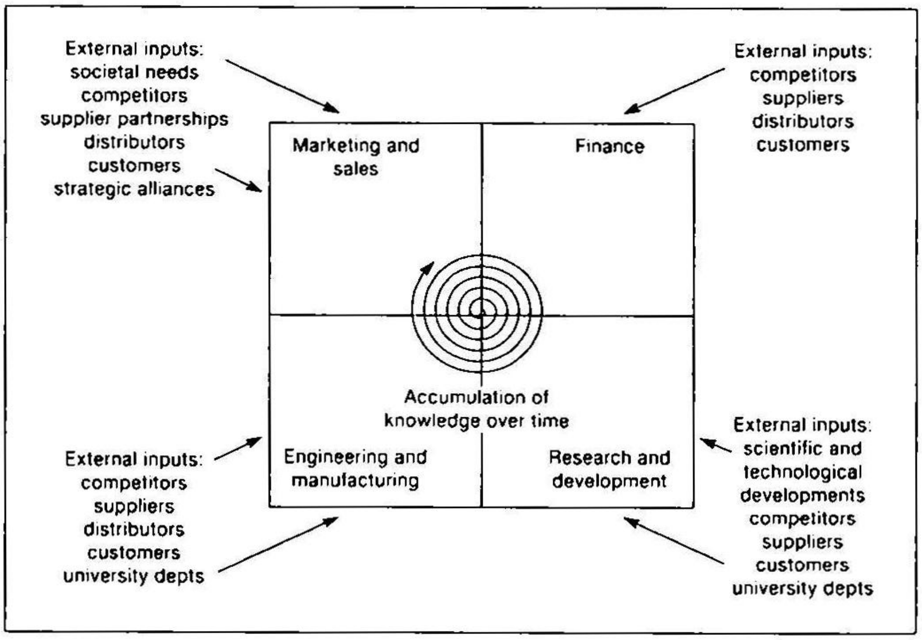


Figure 10. A network model of NPD (Trott, 2012)

These methodologies have been designed to reduce the language barriers between departments and to create efficient collaborative works.
However, further research is needed, since many companies are still struggling to find an effective NPD structure to accomplish an innovative outcome by integrating different functional expert groups (Buchanan, 2001; Gregor et al., 2007; Griffin & Hauser, 1996; Hubbard, 2010).

2.2.4. Summary of Factors Affecting Uncertainty in Early Stage (ES) of NPD

The literature review on factors affecting uncertainty in early stage of NPD showed that uncertainty is mainly related to the level of systematic methodologies and employee involvement in the idea generation phase. In addition, the literature suggested the following salient points that help to reduce uncertainty and enrich innovativeness during the idea generation phase:

- Organisational Learning (OL) and Knowledge Management (KM), which might play a role in the fundamental portion of the idea management system, are used in order to stimulate employees to create ideas and share these ideas in today's knowledge-based competitive environment (Greiner et al., 2007; Jasimuddin, 2008)
- Systematic idea management of NPD, encouraging mutual knowledge flow among employees, can bring innovative results to the organisations (Liebowitz, 2005; Pluskowski, 2002; Ries, 2011). Namely, systematic methodologies enable efficient idea generation activities in NPD (Hubbard, 2010; Ries, 2011)
- A company culture that encourages employees to have ownership and responsibility enables active cooperative work among them (Hardaker & Ward, 1987; Rubenfeld, & Morgan, 1991; Saleh et al., 1993; Sethi et al., 2001)
- Synthesised thinking from a wide spectrum of information from various expert groups gives an advantage to the idea generation tasks of NPD and reduces uncertainty, since NPD is basically a knowledge-based activity

(Brown, 2008; Hatchuel et al., 2010; Lawson et al., 2009; Negroponte, 2003; Sarin & McDermott, 2003)

- Recognising patterns and the big picture of the project is important to all employees as well as decision-makers, since comprehending project context can contribute to reducing uncertainty (Lawson et al., 2009; Reid & De Brentani, 2004; Warren & Fuller, 2009)
- Integration between the research and development departments is a significant tactic in achieving success in NPD (Song, Thieme, & Xie, 1998)
- Cross-functional works are more effective in the planning stages rather than the development stages (Moenaert et al., 1995)
- Increasing the level of employee involvement in projects and giving them ownership is a strategic way to achieve business success (MS-ECE et al., 2014; Olson et al., 1995; Song et al.,1998)
- Internal conflicts are usually affected by how much understanding and anxiety exist in projects, and they arise from variations in ways of thinking, language, and work journeys among the different types of groups (Lam & Chin, 2005; Pelled & Adler, 1994; Rahim, 1986)
- Greater importance is being placed upon building a formal and effective process to integrate the different experts' ideas in NPD (Amabile, 1998; Ekerå & Hallbert, 2015; Griffin & Hauser; 1996; Trott, 2012)

To investigate emerging issues in internal or organisational factors affecting uncertainty in recent NPD, this theoretical study focused on the need for multidisciplinary thinking in idea generation, Further, it addresses the issues that emerge between different functional teams under such a multidisciplinary approach. As a result, this literature section offered key information deeply connected to the correlation between uncertainty and the multidisciplinary approach in ES of NPD process (e.g. systematic idea management, integrating and sharing knowledge, mistrust, internal conflict, language barrier).

These core themes are a significant foundation for subsequent empirical research in this work, confirming the relationship between actual emerging topics and theoretical issues. It allows this study to identify opportunities to establish an efficient and systematic idea generation process in the ES of NPD.

2.3. Factors Affecting Use of Data, Information (DII) and Insights within Idea Generation Activities in the Early Stage (ES) of NPD

Introduction

The development of the internet has offered an environment in which people can easily access huge amounts of data (Ginchereau & Mitchell, 1997; Tanenbaum, 2003). Therefore, the need to study how data are used in NPD is becoming more important. For this reason, the literature review in this section examines the main elements relevant to effective use of data and information, as well as the factors influencing successful data collection, sorting, and analysis.

This subject consists of three sub-themes:

2.3.1. Data Measurement for Collecting Useful Information
2.3.2. Significance of Simplifying Complex Information
2.3.3. Data, Information, and Insights (DII) that Stimulate Innovative Ideas

Knowledge of the advantageous use of data and information would provide current companies with an understanding of how data can help to stimulate the identification and capture of ideas and insights, which in turn can help companies achieve more innovative outcomes.

2.3.1. Data Measurement for Collecting Useful Information

Difficulties in Accurate Data Selection

Because of their convenient access to a wealth of information, web search engines have afforded many the ability to collect data and obtain information (Ginchereau & Mitchell, 1997). They have enabled people to carry out work or enjoy cultural activities, regardless of time and space (Tanenbaum, 2003). The data from web search engines provides plentiful information that is incomparable to other resources (Memmi, 2014). Using text, images, and other formats, search engines provide large amounts of data created in a fast-changing environment (in real time or nearly so) (McAfee et. al., 2012).

However, much of the information from the internet is considered unreliable, and the scope of it exceeds a human's cognitive capacity (Memmi, 2014). A seminal experiment by psychologists has shown that humans can handle only a limited number of pieces of information at any one time, and most people can follow up on no more than three hundred pieces of information at any one time (Miller, 1956). Also, overloading of information brings stress and misjudgement (Eppler & Mengis, 2004). For this reason, internet users often spend much of their time and effort on filtering out inaccurate or false information, as they are not certain whether collected data are reliable or not (Ginchereau et al., 1997; Thomas & Fischer,1997). In other words, filtering inaccurate and uncertain information is one of the key requirements in online data collection situations (Hatchuel et al., 2010; Kusiak & Tang, 2006). In regard to front-end NPD processes, free access to inaccurate and unconfirmed information can lead to great internal confusion and difficulties in decision-making (Collinson & Jay, 2012), as external and internal complexities are strongly interrelated (Collinson & Jay, 2012). Villars et al. (2011) also suggest that this nexus of issues is compounded by the finding that firms often have difficulties in controlling countless and fast-changing amounts of information, which also bring a complicated range of analysis.

For this reason, a number of studies have suggested that companies need to find a new approach to cope with the complexity and uncertainty regarding information gained from a large data environment. Companies are required to consider building sophisticated, customised, and intelligent methods of data filtering (Kusiak & Tang, 2006). In addition, studies have indicated that the systematic selecting of information in a large data environment might contribute to the generation of innovative ideas (Hagel, Seely & Davison, 2008; Hamel & Prahalad, 1991; Hatchuel et al., 2010; Kim & Mauborgne, 1997).

According to Rajpathak and Narsingpurka (2013), a key challenge in analysing large amounts of data is the need to develop intelligent methodologies and algorithms to understand and analyse the data, in order to extract the right information to improve the product development process. For example, Villars et al. (2011) addressed four requirements that can contribute to accurate data selection in a welter of uncertain information: (1) using a computing infrastructure for the collecting, validating, and analysing of large amounts of data; (2) evaluating blended data from many kinds of sources; (3) handling unpredictable and ambiguous information; and (4) collecting and analysing data in real time, while reacting or giving an answer promptly. In addition, as the internet allows most information to be opened and shared, it is possible that competitors can obtain the same information (especially if an NPD project is undertaken by market needs). For this reason, companies need strategic methods enabling unique information to be selected, so that they can make new products distinct from those of their competitors (Björk & Ottosson, 2008).

Range of Data and Measurement

Hubbard (2014) observed that people are often struggling to use information within an unnecessarily large and wider range of information:

> *You have more data than you think, and you need less data than you think (Hubbard, 2014, p. 63)*

Also, there is a consensus among social scientists that, in order to create a successful NPD process, it is necessary to use an intelligent method of selecting appropriate data from a large amount of information, which will minimise uncertainty and can be used in a real project effectively (Hubbard, 2010; Kumar, 2012; Majaro, 1991). Setting a scope of data is regarded as an important element in creating an intelligent information system for a business (Hackathorn, 1998).

The unlimited internet data that most researchers use to search for information may provide a greater potential for new findings. However, it also makes it difficult to determine whether the data actually helps the project, or even has a detrimental effect on decision-making (Langley, 1999; Miles & Huberman, 1994). In addition, a number of studies (e.g. Davenport & Beck, 2013; Gray et al., 2011; Hansen & Haas, 2001) point out that people often optimise retrieving information in order to finish a search quickly (Prabha et al., 2007). For example, they tend to rely on resources of information that are easily accessible (Leckie et al., 1996) or are locally relevant (Choo, 1998). For this reason, many studies of data measurement and uncertainty emphasise the importance of a proper range of data for an accurate evaluation of information and the reduction of uncertainty (e.g. Hubbard, 2010; Majaro, 1991).

The studies have also described that defining precise problems or issues helps to build an appropriate range of data (Hubbard, 2010; Majaro, 1991). According to

Majaro (1991), a well-stated problem potentially equals half the solving of a problem. In particular, the analysis of well-defined problems is regarded as a valuable part of a process for innovative projects (Hodnett, 1955; Hubbard, 2010; Majaro, 1991). Marjaro (1991) named this ‘normative innovation’ as being the process that removes problems during the identification of the problems. In his major study in 1991, Marjaro discussed how innovation can be accomplished while struggling with well-defined problems, whereas ill-defined problems do not stimulate useful sources of creative brainpower.

> *Problems can only be solved if their precise nature and causes are known. The task of solving problems is devoted time towards collecting data, analysing, diagnosing the causes, but finally generating ideas likely to solve them. (Majaro, 1991, p.109)*

In a view similar to that of Marjaro (1991), Hubbard (2010) stated that the measurement for understanding existing problems or issues within a proper range of data enables the reduction of project uncertainty and risk. In discussing how to provide such measurement, Hubbard first presented the definitions of related key words (measurement, uncertainty, and risk) in his 2010 publication *How to measure anything: Finding the value of intangibles in business.*

- *Measurement: a quantitatively expressed reduction of uncertainty based on one or more observations*
- *Uncertainty: the lack of complete certainty, that is, the existence of more than one possibility, the ‘true’ outcome/state/result/value is not known*
- *Risk: a state of uncertainty where some of the possibilities involve a loss, catastrophe, or other undesirable outcome, as well to discover the relationship among those three key words*

(Hubbard, 2010, p. 50)

Hubbard’s research (2010) suggests that people or companies need to think about the answers to the following three questions in order to clarify their issues and problems:

1) Why do you want to know?

2) How much do you know now?

3) What is the value of the additional information?

In conclusion, companies need intelligent data-sorting methods in order to reduce uncertainty and achieve innovative results, and the setting of an appropriate information range may enable this to happen. In addition, identifying existing problems will be a key point in establishing standards for the scope of information.

From Data to Insight

The current technology allows analysts to interpret a large amount of data obtained from a variety of resources, and to apply the results to real projects (Sharma et al., 2010). Also, recent analysts are able to utilise abundant methods of data analysis accordingly (Davenport et al., 2010; Davenport & Harris, 2007). Despite this technological development, however, insights do not automatically emerge from the results of mechanical analysis through software. As Lycett (2013) observed, using automated business analytics tools normally enables researchers to easily obtain statistical patterns, trends, and relationships of data; yet, defining value in the meanings of the results is still a task people struggle with in generating human insights.

A good understanding of the ‘data to insight’ process can be an important basis for comprehending how the results of data analysis affect business improvement (Sharma et al., 2014). This is because specific insights obtained from data analysis can generate successful project outcomes through offering new opportunities to the NPD programme (Nijssen & Lieshout, 1995). One study by Sharma et al. (2014), which is referred to in many studies of insights (Sodenkamp et al., 2015), examined the journey from data to decision value. According to them, having multiple kinds of participants from different departments for data analysis activities is regarded as a key factor in generating valuable insights from various types of knowledge and data. Shanks et al. (2010) and Sodenkamp et al. (2015) also agree that the involvement of various experts from different teams, including analysts and business managers, might be helpful in generating valuable insights, as the diverse experts can decode the meaning of the results of the data analysis variously and accurately. These findings suggest that the use of various perspectives from diverse areas can outperform the insights of individual analysts or business managers by providing integrated, outstanding insights through the knowledge synthesised from each field of expertise (Jansen & Goldsworthy, 1995; Nissani, 1997).

Lack of time, resources, and concentration are often included as other factors that influence the ‘data to insight’ process in a company (Lesser et al., 2000).

2.3.2. Significance of Simplifying Complex Information

Significance of Simplifying Complex Information

The complexity of information is regarded as a natural reflection of the recent complex environment in the market. However, a number of researchers and scientists have emphasised the high effectiveness of simplicity in project management because of its relevance to competitive outcomes (Langley, 1999; Lombrozo, 2007). Well-defined processes, using neat and linear resources, usually bring about well-defined results (Schwenk, 1985; Van de Ven, 1992). Thorngate (1976) and Weick (1979) have previously described simplicity as one of the important ingredients in a research strategy, combined with accuracy and generality. Baker (2004) has supported the principle of William of Occam, known as Occam's Razor; the number of descriptions should not be multiplied unnecessarily. Also, multiple scholars have assisted in a methodology for simplicity called 'inference to the best explanation': for the explanation, choose the closest evidence or the simplest structure (e.g. Harman, 1965; Lipton, 2002; Lombrozo, 2007). In 1993, Read and Marcus-Newhall demonstrated in their influential tests that a higher percentage of participants are more stimulated by the simple version of a description than a complicated one.

Although simplifying information has become more demanding in recent studies and markets, it is often difficult to align such transformed simple information accurately with the original intention (Mintzberg, Raisinghani, & Theoret, 1976; Nutt, 1984; Schroeder, Van de Ven, Scudder, & Polley, 1989) because of unexpected obstacles in certain massive and complex circumstances (Hatchuel et al., 2010; Kim & Wilemon, 2003; Kusiak & Tang, 2006; Miles & Huberman, 1994). For instance, the advent of the internet has brought not only easy access to relevant data and information, but it has also increased the use of inaccurate and uncertain information (Hatchuel et al., 2010; Kusiak & Tang, 2006). In addition, a large amount of data to be refined and understood might build a sense of confusion if presented as an unstructured mass of information, which is called 'death by data asphyxiation' (Pettigrew, 1990). This scenario leads to ambiguity and can make core subjects unclear (Langley, 1999). Therefore, developing strategic ways to transform and simplify complex information into usable, accurate data is regarded as a crucial task for researchers and organisations today (Collinson & Jay, 2012). In particular, Kim and Wilemon (2003) have reported that the NPD process can be very complex, since it generally seeks innovation outcomes using multidisciplinary information and people, and it needs newness distinct from existing results. For innovation of NPD, a high standard of synthesis of individual resources is needed.

Another factor that affects complexity is the market's own complication. Market needs change fast, and they are often dynamic in nature. For these reasons, many product developers encounter difficulties within this market atmosphere, due to the unexpected emergence of technologies, customer needs, competitors, political risks and regulations (Hatchuel et al., 2010; Kim & Wilemon, 2003; Pink, 2006). Several studies have pointed out that organisations face a challenge in improving their information processing systems in preparation for unpredictable complexity in their market (Dess & Beard, 1984; Lawrence & Lorsch, 1969; Mintzberg, 1979; Ruekert & Walker, 1987). Collinson and Jay, the authors of *From complexity to simplicity* (2012), state that complexity can impact achievement motivation, reduce the speed of a process, waste resources and, finally, affect a project's profits. For this reason, they addressed the need to develop an efficient system using clear and simple methodologies to avoid the chaos of this complexity (Collinson & Jay, 2012).

Simplicity is described by many researchers as one of the kernel ingredients in NPD processes (e.g. Collinson & Jay, 2012; Hatchuel et al., 2010; Langley, 1999; Lombrozo, 2007; Pink, 2006), and they also indicate that the simplified information needs to be easily interpretable (De'ath & Fabricius, 2000). Eisenhardt (1989) previously suggested that, when information is adjusted, it is expected to indicate a strong foundation of a transforming mechanism with its core original data, and to show a theoretical base to enhance validity and trust. Daft's statement (1983) represents well how to deal with information within research works; as reflected in the following quote, good research should be like a poem, not a novel.

> *Design research as a poem, not as a novel… Poetry seems to have greater applicability to organizational research. Poetry means a research design that includes only a few, perhaps two, three, or four variables. But they must hang together in a meaning unit, a coherent framework of sorts, that explains some aspect of organizations. A research poem also must have depth. The meaning unit must take a deep slice into organizations and convey a rich conceptualization to others… (Daft, 1983, p. 541)*

Knowledge sharing through visualisation

The purpose of visualisation of information or knowledge is to improve its exchange between more than two people at least by using visualisation methods such as sketches, diagrams, images, objects, and interactive visualisations (Eppler & Burkhard, 2004).

Specifically, knowledge visualisation concentrates on improving the results of various knowledge-sharing activities (such as exchanging insights, experiences, attitudes, perspectives, and opinions) and on generating new ideas among the participants, as well as enhancing people's cognition to see patterns and trends by providing graphics (Bederson & Shneiderman; 2003; Card et al., 1999; Card et al., 2009; Heer et al., 2010).

Knowledge visualisation is normally regarded as a strategic methodology to assist people to organise, recognise, build, and evaluate their knowledge and ideas, and also to use these aspects to establish effective communication (Card et al., 1999; Holley & Dansereau, 1984; Tergan, 2003). It is also a crucial ingredient for the innovative and cognitive tasks of creating new products (Wikström, 2010). In particular, the importance of visualising data is usually mentioned in the initial phases of projects (Graell-Colas, 2010). In *Disrupt* (2010), Williams stated that:

> *explaining ideas in words is general and abstract. And an abstract idea is harder to understand and remember for both you and anyone else you might want to share it with. On the other hand, explaining ideas in visualisation makes them easy to share, understand, and remember. (p. 94)*

In other words, visualising helps people to comprehend easily how your idea works, without any misunderstanding. Williams (2010) has illustrated that "ambiguity disappears when you describe your ideas in visual form" (2010, p. 82). Abigail Sellen and Richard Harper, the authors of *The Myth of the Paperless Office* (2003) also agreed that explaining ideas by various complementary visualisation methodologies is an effective method of sharing information with people in the office. They have proved it to be advantageous when certain kinds of creative tasks were performed with visualisation methodologies on various kinds of projects. Holloway's analysis about visualisation (2009) also showed that using visualised references or actual objects to explain ideas has a crucial advantage on sharing knowledge and communication among different participants. It may also offer clarity and transparency to suggested ideas while these ideas are being investigated by different groups of people. In his paper, Holloway introduced one of his tests to demonstrate the benefits of data visualisation in developing ideas among people from different types of groups. In this test, the visual materials about a new project were set in one place, and each team then came there daily to realign priorities based on their own analysis. This example clearly shows how visualisation enables people who have different types of professional expertise and knowledge to understand other members' activities. Cagan and Vogel (2002) hold a view similar to that of Holloway regarding the importance of sharing knowledge visualisation among multidisciplinary teams or work projects. According to them, in order to successfully gain insights among the different types of groups or people from collaborative works, it is generally necessary to develop a common understanding between all participants using visualised methods for the related information (e.g. consumers, context, members' individual perspectives).

> *All [this] information must be processed by the team so that all team members have a shared understanding... Whether it is a case of dealing with inter- or intra-team communication, visualizing early and often is essential to develop that shared understanding. (Cagan & Vogel, 2002, p. 2007)*

Many studies of knowledge visualisation identified that visualising ideas and information might form a crucial part of a strategic tool for sharing knowledge (Keller & Tergan, 2005). In particular, they focused on the benefit of the knowledge visualisation that enables people to find core patterns in complicated information and that can help reduce their anxiety levels (e.g. Graell-Colas, 2010; Sweller & Chandler, 1994; Ware, 2004; Wiegmann et al., 1992).

In 2004, Ware published a paper demonstrating that visualisation enables people to understand complex concepts (Keller & Tergan, 2005). Also, Graell-Colas (2010) discovered that transferring complicated information into a simple mode of visualisation could enhance the common level of understanding among people (Graell-Colas, 2010). That is because the core purpose of visualisation is to support people to find patterns easily in involved or puzzling information (Ware, 2004; Wiegmann et al., 1992).

These theoretical findings have stated that visualisation reduces levels of anxiety, enables people to capture the key ideas, and allows them to expand their memory when people are dealing with complicated information (Cox & Brna, 1995; Sweller & Chandler, 1994).

2.3.3. Data, Information, and Insights (DII) that Stimulate Innovative Ideas

Stimulus Data

Investigating information and data stimulating successful research goals is a common theme in a variety of knowledge areas, including innovation and business (Lněnička et al., 2016; Sindakis, 2017; Wright, 2016). Regarding this, several definitions of stimulus data have been given in various research fields. According to Bachmann (1989), stimulus data is the data conceptualised by decoding processes from first-input information, and Koenemann et al. (2003) stated that stimulus data constitutes the data sifted and stored into one's knowledge warehouse in a ready-to-apply form. Al-Fedaghi (2012) illustrated stimulus data as a kind of perceived data that may trigger a mental flow process. Therefore, the common characteristic of stimulus data from these definitions is that it is factual and/or refined, and highly usable when applying knowledge to actual projects.

Factual, Refined, Creative Catalyst Data

Factual data is usually defined as the basic data not yet analysed and interpreted, but helpful for projects to specify their plan, along with an automated filtering system (mainly using specialised quantitative computer software) (Kuhn et al., 2012). Factual data is also often mentioned as integral to research data, since the factual information is able to add value to the study through the provision of context of the issues, thereby contributing to enrichment of the reason for the research (Bristol University, n.d.; Rusbridge et al., 2005). Thus, factual data can be characterised as being realistic, raw, comprehensive and helpful, such as PESTE (i.e. data indicating present Political, Economic, Social, Technological, and Environmental circumstances) (Deryn, 2007).

The term 'refined data' refers to data that is analysed and interpreted by merging and reconciling different kinds of data sources based on the facts collected (Intriligator et al., 1978). The result is a set of synthesised and sophisticated data that can affect the decision-making of a product concept (Anyaehie, 2016; Intriligator et al., 1978). In general, data refining is conducted within qualitative data analysis. Refined qualitative data is the result of following qualitative data analysis activities, such as sorting, merging, breaking, reorganising, and synthesising data to find patterns. It enables people within organisations to identify what is core, what they need, and which information is to be shared with others (Bogdan & Biklen, 2007; Mogashoa, 2016). A persona is an example of refined data. In user-centred research, personas are fictional characters that can represent various types of users (Lidwell et al., 2010).

'Creative catalyst data' is categorised as data that can directly inspire creativity using personal insight from materials related or unrelated to the original subjects. For example, Gates et al. (2016) have demonstrated the relationship between creative catalysts and material that is completely unrelated to their original subjects, through using insects as an inspiration when designing a new building. The project of Gates et al. is also associated with the impact of emotional factors on stimulating creativity, and several studies have found that factors affecting employees' emotions are helpful in boosting their creativity and motivation (Morris et al., 2013; Morris & Picard, 2014). Hence, all kinds of materials that are highly usable for increasing creativity can be identified as creative catalyst data.

	Factual Data	Refined Data	Creative Catalyst
Feature	• Related to subject	• Related to subject	• Related or Unrelated to subject
Characteristic	• Comprehensive • Realistic • Raw	• Synthesised • Usable • Rational	• Intuitional • Emotional
Aim	• To comprehend context of market needs	• To find key issues • To make decision	• To get inspiration • To achieve creativity
Example	• PESTE	• Persona	• Picture

Table 9. Basic characteristics of three types of data

Studies about types of data and data analysis methods are becoming core themes in NPD studies, since data are the ingredients that are converted to insights applied to NPD projects (e.g. Lesser et al., 2000; Sharma et al., 2014; Sodenkamp et al., 2015). In particular, recent complex market dynamics and big data environments have accelerated the need to clarify data more effectively (Kusiak & Tang, 2006; Memmi, 2014).

Use of Data

When data are collected, many research organisations tend to focus on the quantity, rather than how to collect data (Poetz et al., 2012). In addition, organisations often rush to generate ideas and filter data, which can lead to failure to derive meaningful and value-adding information from data collection and use (Flint, 2002). Therefore, reviewing the nature of the methods for data collection or the patterns of its use, in terms of (1) contents, (2) resources, and (3) formats, enables people or organisations to gain more competitive insights from the data collected (Hambrick, 1982; Lozada & Calantone,1996; Utterback, 1979). In addition, the establishment of systematic data selection methods, based on knowledge of data usage patterns, may lead to the discovery of meaningful information that brings innovative insights (Nijssen & Lieshout, 1995; Van Kleef et al., 2005).

(1) Contents: Importance of consumer data

It is now well established that understanding consumer needs and their feedback is an important factor for driving new product development (Brown & Eisenhardt, 1995; Ehrenberg, 1996; Rosenberger, 2015). As consumer data are becoming increasingly crucial, even in technocentric companies, many firms try to obtain and use consumer data from the beginning of their NPD projects in order to predict consumer reaction to new products (McGuinness & Conway, 1989; Van Kleef et al., 2005). The main role of research in the initial stage is to explore consumer needs that are not yet met, and to focus on identifying new opportunities emerging from them (Van Kleef et al., 2005). On the other hand, some studies showed doubt about the effectiveness of consumer needs data at the initial stage of NPD, since the studies identified that even consumers are not sure about what they need in the future (Ulwick, 2002).

However, it has long been established that analysing consumer needs and new social behaviour data at an early stage is believed to increase the chances of NPD project success (Rochford, 1991; Van Kleef et al., 2005). Rochford (1991) commented that, although identifying exact consumer needs is difficult, it is important to understand the context of how their needs form and emerge.

Therefore, consumer data is considered key to success in today’s NPD, and well-defined consumer data enable companies to engender distinctive insights for achieving innovative outcomes (Ehrenberg, 1996; Van Kleef; 2005).

(2) Resources: Increased data collection due to technology development

Typically in NPD projects, the expert research groups mainly conduct most of the data work such as collecting, analysing, and delivering the data and information to other teams in the organisation (Griffin & Hauser,1996; Veryzer, 1998). However, the advent of an internet-centric information environment has enabled individuals to access web search engines directly in order to collect information individually

(Ginchereau & Mitchell, 1997; Memmi, 2014). In addition, such advancement of the technology has led not only to new approaches to data collection, but has also resulted in creating new types of resources and formats (e.g. applications for smart devices) (Husain, 2010; Marzouki et al., 2013).

(3) Data Formats

Several data format types are applied in product development projects, such as text, image, video, sounds, and samples, and these various types of data can be used with great flexibility depending on the purpose (Aho et al., 1986). For example, text data is primarily used in describing details of information, and images are normally used when simplifying information (e.g. graphs/charts) or supplying inspiration (e.g. a picture).

Quantitative and Qualitative Data Analysis

A number of studies have examined the characteristics of quantitative and qualitative data, including the use of both types in NPD processes (e.g. Miles, 1994; Neuman, 2002). In general, the nature of quantitative data analysis is known to be objective and numerical (often using statistical analysis), while that of qualitative research methods is perceived to be subjective and interpretive, using personal judgement (Jeans, 1992; Khun, 1963).

Quantitative data analysis is usually regarded as a fact-centred method, which is usually related to knowledge of a rule or a relationship between facts proven through statistical analysis (Pugh & Hickson, 1976). Therefore, the factual analysis is believed to be able to validate the needs of the research by sharing objective points of views about its purpose (Jean, 1992). In contrast, qualitative data analysis is normally conducted using subjective interpretation and various assumptions. Personal cognition about the information plays a major role in interpreting data to obtain insights (Burrell & Morgan, 1979; Jean, 1992). Therefore, in the study of qualitative data, understanding its flow and resulting interpretation has been identified as vital for grasping the meaning of its results (e.g. Burrell & Morgan, 1979; Dey, 2003; Jean, 1992).

Furthermore, a number of data analysis studies suggest that a blended method of quantitative and qualitative data helps to overcome the limitations of one type of data, with one strengthening the other (Bamberger, 2012; Carvalho, 1997; Greene, 2007; Khun, 1963).

2.3.4. Summary of Factors Affecting Usage of Data, Information and Insights (DII) within Idea Generation Activities in Early Stage (ES) of NPD

The literature review helped to identify the following key issues that affect maximising the effectiveness of data use in the idea generation phase of NPD:

- Establishing a range of data and information is emphasised when creating an intelligent information system for an innovative business, since it enables an accurate evaluation of information and reduces uncertainty (Hackathorn, 1998; Hubbard, 2010)
- A precise comprehension of the existing problem helps to determine the scope of the data (Hubbard, 2010; Majaro, 1991; Villars et al., 2011)
- Despite the development of technology such as business analytics tools, data and information eventually turn into an idea through human insight (Lycett, 2013; Sharma et al., 2014; Sodenkamp et al., 2015)
- Use of various perspectives from diverse areas can outperform the insights of individual analysts through synthesised knowledge between each field of expertise (Cagan & Vogel, 2002; Jansen & Goldsworthy, 1995; Nissani, 1997)
- Simplifying complex information enables data to be more usable and useful (Collinson & Jay, 2012; Daft, 1983; De'ath & Fabricius, 2000)
- Visualisation can foster efficiency when data are simplified and shared (Bederson & Shneiderman; 2003; Card et al., 2009; Heer et al., 2010; Wikström, 2010; Williams, 2010)
- The common characteristic of stimulus data – which stimulates idea generation – is that it is highly usable when applying knowledge to actual projects (Al-Fedaghi, 2012; Bachmann,1989; Koenemann et al., 2003)
- The establishment of systematic data selection methods, based on knowledge of data usage patterns, may lead to the discovery of meaningful information that brings innovative insights (Nijssen & Lieshout, 1995; Van Kleef et al., 2005).
- The advent of the internet has led to many advantages in collecting data; however, it has also brought about the use of inaccurate and uncertain

information caused by a large amount of unfiltered information (Griffin & Hauser,1996; Hatchuel et al., 2010; Kusiak & Tang, 2006)

- A number of data analysis studies suggest that a blended method of quantitative and qualitative data help to overcome the limitations of one type of data by strengthening each other (Bamberger, 2012; Carvalho, 1997; Greene, 2007)

This section reviewed multiple previous studies related to obtaining data, information, and insights that stimulate idea generation in order to explore knowledge of data usage patterns and emerging issues linked to the data usage. This literature review thereby provided a basis for studies of comparisons between theoretical and emerging issues related to data stimulating idea generation in recent NPD practice.

2.4. Literature Review Conclusions

The literature review has established an in-depth overview of factors and opportunities that can lead to reduced uncertainty in the idea generation phase of the NPD process, especially for MNEs centred on cross-functional tasks. Thereby, the findings from this chapter have helped to provide the theoretical basis for the subsequent empirical study.

Section One (Factors Affecting Front-End Innovation and Idea Generation) indicated that companies currently face high levels of uncertainty in their NPD projects, linked to a range of issues such as information overload and rapid changes in technologies and markets (Garnsy & Heffernan, 2005; Sarasvathy, 2001). In addition, a company's ability to respond flexibly to changing consumer needs, in line with complex social structures, was identified as a crucial factor for achieving successful outcomes (Kusiak & Tang, 2006; Pink, 2006). In addition, many studies have illustrated the importance of idea generation stage of NPD, idea quality, and innovative ideas, which stem from unconventional thinking (Martin, 2009; Pink; 2006; Williams, 2010). The literature also indicated the importance of considering effective methods of transitioning high-quality innovative idea into actual practice in NPD (Briggs et al., 2007; Cross, 2001; Hart et al., 2003; Hatchuel et al., 2010; Reinig & Briggs, 2008).

In the second part of the literature review (Factors Affecting Uncertainty in the Early Stages of NPD), a number of studies emphasised that integrating diverse knowledge from different expert groups is the key factor in reducing uncertainty in the idea generation stage (e.g., Brown, 2008; Hatchuel et al., 2010; Negroponte, 2003; Nissani, 1997). Also, they focused on systematic management as the crucial basis for obtaining a successful synthesis of various perspectives and knowledge (Foucault, 2000; Hatchuel et al., 2010; Hubbard, 2010; Pugh, 1991). Active intercommunication has been identified as a key factor in helping employees share project context, which may contribute to reducing internal conflicts and mistrust (Pelled & Adler, 1994; Sethi & Park, 2001; Song, Thieme, & Xie, 1998). Internal conflicts mainly come from the gap in perspectives on the same information between different types of functional teams (Griffin & Hauser, 1996; Lam & Chin, 2005).

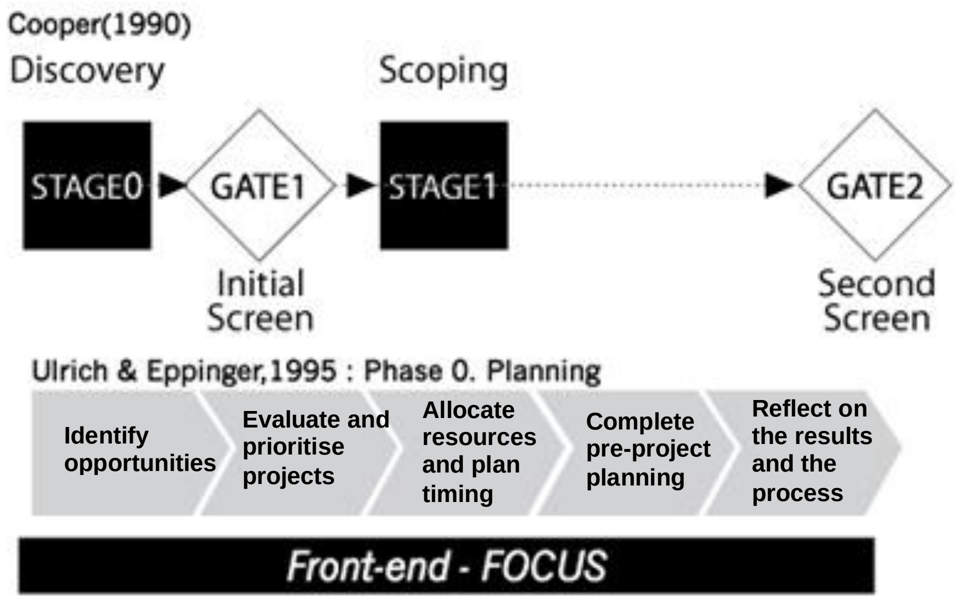
For this reason, many studies addressed the importance of having various teams involved in the idea generation stage to establish better mutual trust through the sharing of ideas (Moenaert et al., 1995; Song, Thieme, & Xie, 1998; Souder, 1987). In addition, the studies discovered that employees' strong psychological ownership of the project from their high level of involvement encourages more cooperative performance and motivation (e.g., Abrashoff, 2007; Buckingham & Clifton, 2001; Pierce, Rubenfeld, & Morgan, 1991).

The final section (Factors Affecting the Use of Data, Information, and Insights within Idea Generation Activities in the Early Stages of NPD), explored the characteristics of data that potentially help to stimulate innovative ideas and the emergent issues. This is because, in NPD projects, understanding the characteristics and different types of data can significantly contribute to a successful interpretation and translation of data into innovative insights (Kusiak & Tang, 2006; Lesser et al., 2000; Memmi, 2014; Sodenkamp et al., 2015). A number of studies of data and idea generation focused on extracting meaningful data from a large amount of information after the advent of the internet (e.g., Griffin & Hauser,1996; Hatchuel et al., 2010; Kusiak & Tang, 2006). For this reason, the studies emphasised setting an appropriate range of data, based on a precise understanding of existing problems, in order to obtain proper information that facilitates innovative idea generation, given the massive amount of information (Hackathorn, 1998; Hubbard, 2010). Furthermore, several studies identified that simplifying complex information enables data to be more usable and useful, and visualisation of data was considered as a key method of achieving the simplifying of complex data (e.g., Card et al., 2009; Collinson & Jay, 2012; De'ath & Fabricius, 2000; Heer et al., 2010; Williams, 2010).
In addition, the findings of this section showed the importance of the blended method of quantitative and qualitative data, in order to obtain distinctive insights for achieving innovative outcomes (Bamberger; Carvalho, 1997; Ehrenberg, 1996; Greene, 2007; Rosenberger, 2015)

Through critically reviewing the themes of idea generation and idea quality, uncertainty in the early stages of NPD, and use of data, the emerging issues underpin the following four main research questions, which will be explored in the main study:

RQ1: What are the current nature of the idea generation processes and the importance of idea quality in ES of NPD processes?
RQ2: What are the reasons for initiating new projects, and what is the nature and level of involvement of various functional groups in the idea generation phase?
RQ3: What are the factors that affect uncertainty when generating and developing new ideas?
RQ4: What data types, resources, and formats are typically used in stimulating or generating new ideas?

The literature review, using a multi-theme model of investigation, has enabled this study to build the theoretical basis of the empirical study systematically (see Figures 11, 12 and 13).

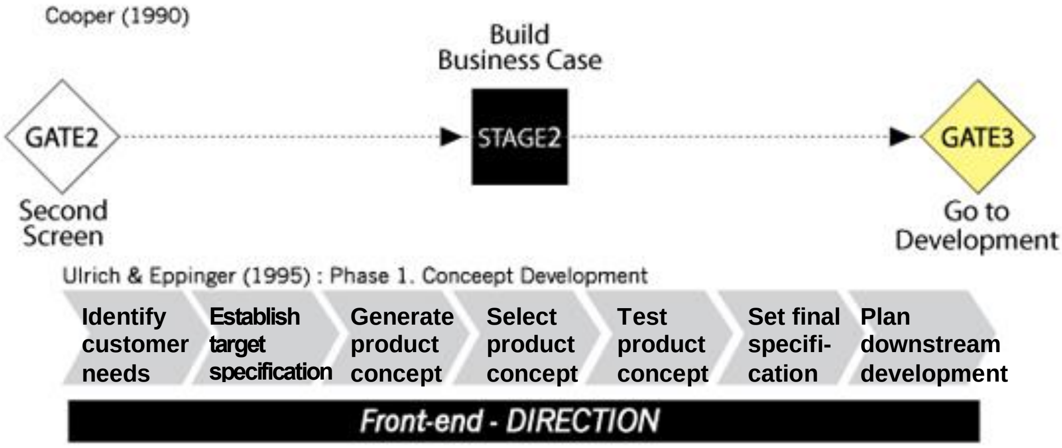


Key Literature Issues

- Uncertain market and business environment (Cross, 2001; Ries, 2011)
- Mistrust due to different language between diverse expert groups (Van Der Vegt & Bunderson, 2005; Williams, 2001)
- Need for systematic idea management (Hubbard, 2010; LaValle et al., 2011; Pugh, 1991)

• Uncertain market and business environment (Cross, 2001; Ries, 2011; Sarasvathy, 2001) • Internal conflicts due to different languages between diverse expert groups (Van Der Vegt & Bunderson, 2005; Williams, 2001) • Multiple methods when collecting data (Brown & Eisenhardt, 1995; Poetz et al., 2012; Rosenberger, 2015) • Complexity to simplicity in data use (Cagan et al., 2002; Collinson& Jay, 2012; Ware, 2004)	• Mistrust due to different perspectives in obtaining ideas and information between diverse expert groups (Briggs & Reinig, 2010; Song et al., 1998; Trott, 2012) • Need design thinking – blended multiple types of approach while generating ideas (Brown, 2008; Martin, 2010; Pink, 2006; Verganti, 2009)	• Need for employees to see the big picture (i.e. understanding the whole project) (Lawson et al., 2009; Sarasvathy, 2001; Warren & Fuller, 2009) • Systematic idea management (Hubbard, 2010; LaValle et al., 2011; Pugh, 1991) • Complexity to simplicity in data use (Cagan et al., 2002; Collinson& Jay, 2012; Ware, 2004)	• Systematic idea management (Amabile, 1998; Hubbard, 2010; LaValle et al., 2011; . Pugh, 1991) • Learning from failure and pivot point (Bonabeau et al., 2008; Cross, 2001; Ries, 2011; Sethi et al., 2001) • Balance between rational and emotional thinking (Campbell et al.; Martin, 2009)	• Mistrust due to different language between diverse expert groups (Van Der Vegt & Bunderson, 2005; Williams, 2001) • Benefit of multidisciplinary thinking when developing new products (Holloway, 2009; Lawson et al., 2009); Negroponte, 2003; Warren & Fuller, 2009)

Figure 11: Key literature issues – focus stage

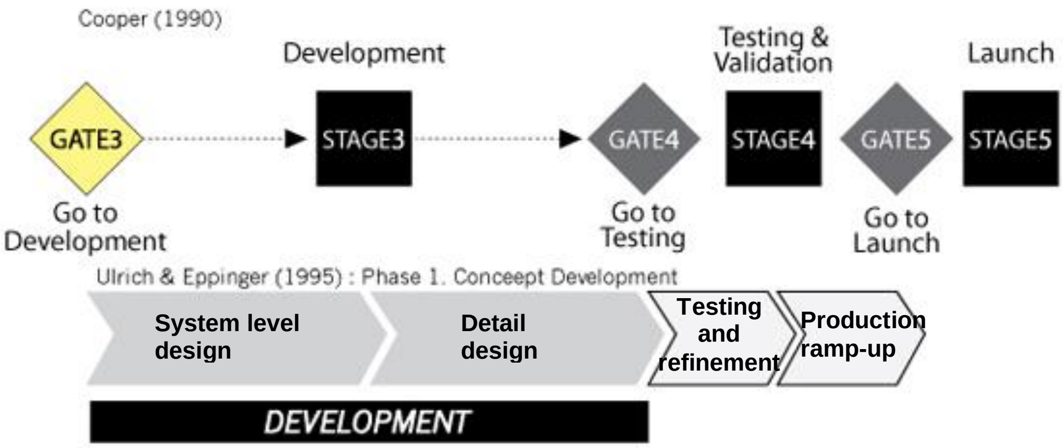


Key Literature Issues

- Benefit of blending multiple ideas (Holloway, 2009; Negroponte, 2003)
- Correlation between level of uncertainty and employees' awareness of big picture of projects (Oh et al., 2012; Sarin & McDermott, 2003)
- Need for an appropriate level of engagement by employees to achieve high-quality cooperation (Abrashoff, 2007; Rochford,1991; Song et al., 1998)

• Importance of consumer data (Rochford, 1991; Ulwick,2002 ; Van Kleef et al., 2005) • Mistrust due to different language between diverse expert groups (Van Der Vegt & Bunderson, 2005; Williams, 2001) • Systematic idea management (Amabile, 1998; Hubbard, 2010; LaValle et al., 2011); Pugh, 1991; • Giving freedom to employees when driving data (Amabile, 1998)	• Benefit of blending multiple ideas (Holloway, 2009; Lawson et al., 2009; Negroponte, 2003; Warren and Fuller, 2009) • Internal conflicts caused by lack of understanding of other people's perspectives (Pelled & Adler, 1994; Rahim, 1986; Xie & Song et al., 1998)	• Need for appropriate level of employees' engagement to achieve high-quality cooperation (Abrashoff, 2007; Rochford,1991; Song et al., 1998; Souder, 1987) • Importance of human insight when developing ideas (Lycett, 2013; Shanks et al., 2011) • Defining idea quality (Briggs & Reinig, 2010) • Mistrust due to different perspectives in defining idea quality (Van Der Vegt & Bunderson, 2005; Williams, 2001)	• Difficulties in accurate selection of information and ideas (Eppler & Mengis, 2004;Kusiak & Tang, 2006;Schon,1983) • Uncertainty due to a lack of conviction in the decision making and quality of ideas (Oh et al., 2012; Sarin & Mc Dermott, 2003)	• Internal conflicts due to different language between diverse expert groups (Van Der Vegt & Bunderson, 2005; Williams, 2001) • Over reliance on the usage of old process and one-sided information (Hodnei,1955; Hubbard, 2010;Majaro,1991) • Fast failure and pivot point (Majaro,1991; Ries, 2011)	• Internal conflicts due to different language between diverse expert groups (Van Der Vegt & Bunderson, 2005; Williams, 2001) • Fast failure and pivot point (Majaro,1991; Ries, 2011) • Systematic idea management (Amabile, 1998; Hubbard, 2010; LaValle et al., 2011; Pugh, 1991)	• Mistrust due to different languages between diverse expert groups (Van Der Vegt & Bunderson, 2005; Williams, 2001) • Correlation between level of uncertainty and employees' awareness of big picture of projects (Oh et al., 2012; Sarin & Mc Dermott, 2003)

Figure 12: Key literature issues – direction stage



Key Literature Issues

- Internal conflicts caused by lack of understanding of other people's perspectives (Pelled & Adler, 1994; Rahim, 1986; Xie & Song et al., 1998)
- Correlation between level of uncertainty and employees' awareness of big picture of projects (Oh et al., 2012; Sarin & McDermott, 2003)
- Complexity to simplicity in data use (Cagan et al., 2002; Collinson & Jay, 2012)

- Internal conflicts caused by lack of understanding of other people's perspectives (Pelled & Adler, 1994; Rahim, 1986; Xie & Song et al., 1998)
- Mistrust due to different language between diverse expert groups (Van Der Vegt & Bunderson, 2005; Williams, 2001)
- Systematic idea management (Amabile, 1998; Hubbard, 2010; LaValle et al., 2011; Pugh, 1991)
- Benefit of visualisation of data; helping a person's cognitive ability to absorb complex information (Cagan & Vogel, 2002; Ware, 2004; Wiegmann et al.,1992)
- Setting range of data for accurate evaluation of information and reduction of uncertainty within vast amounts of data (Davenport & Beck, 2013; Hubbard, 2010)

- Correlation between level of uncertainty and employees' awareness of the big picture of projects (Oh et al., 2012; Sarin & Mc Dermott, 2003)
- Internal conflicts caused by lack of understanding of other people's perspectives (Pelled & Adler, 1994; Rahim, 1986; Xie & Song et al., 1998)
- Mistrust due to different language between diverse expert groups (Van Der Vegt & Bunderson, 2005; Williams, 2001)

Figure 13: Key literature issues – development stage

3. Operationalising the Study: Approach and Methods

Introduction

The goals of this chapter are to describe the underpinning approach and rationale for the research, and the development of tools adopted to facilitate its operationalisation. The chapter will provide a structured overview of choices that were made in planning and developing the research, and present a detailed overview of key features of the implementation of the work. It will also detail the selection and development of research tools and explain how and why these were deployed in the study. The section will also discuss issues relating to data capture and analysis, and the combination of data collected throughout the various phases of the study.

The structure of this chapter is as follows:

3.1. Context and Rationale

The following information describes the philosophies and rationales that influenced the direction of this study. Many studies emphasise the importance of consumer needs and the ability of companies to meet them in relation to today's rapidly evolving and uncertain market conditions (Ledwith et al., 2006; Pink, 2006). Such studies have also found that the companies' ability is deeply related to successful product innovation (Eisenberg, 2011). For this reason, the importance of front-end research that facilitates the process of generating ideas is emphasised in the context of bringing out product innovations in such a complex environment (Bhamra, 2004; Cooper, 1997, 2001).

Innovative and differentiated products are becoming increasingly important as, with the development of technologies, mass production has become a global form of industry, and consumers now have multiple purchase options (Pink, 2006; Verganti, 2009). In this regard, research about the impact of front-end activities on the success of NPD is being actively implemented (e.g. Koen et al., 2001; Ölundh & Tingstrom, 2008). Furthermore, many researchers have found it difficult to adopt research results into the development of real products, and this is one of the most significant obstacles to creating innovative products, especially for large companies (Buchanan, 2001; Hubbard, 2010). In addition, despite the many decades of studies on the lack of applying research results to the development of real products (Flynn et al., 2003), it is still a challenge for both academics and companies. The recognition of this situation led to this study's investigation of what disconnections and hampering factors are evident, amongst whom and why, and how these issues might be transformed into opportunities.

Therefore, this study is designed to find opportunities for multinational industrial corporations to improve the links between front-end activities and subsequent product development activities, and to reduce the gap between them.

This study specifically examines these issues in terms of the following two research goals: (1) to understand how organisations' actual idea generation activities and related work might differ from academic theorisation of such undertakings, and (2) to identify clues, via a comparison between theory and practice, that will assist in solving problems in order that companies can more effectively create innovative products.

Based on extensive literature review, the following four key factors related to actual front-end practices of MNEs have been identified: (1) ideas and the nature of idea generation processes, (2) NPD initiation and the people involved, (3) uncertainty in idea generation, and (4) data, information, and insights that stimulate generation of ideas. These four factors form the main question areas that are addressed by the empirical research. This study deploys primarily the NPD models formulated by Cooper (1990) to implement the more structured exploration. Also, Ulrich and Eppinger's (1995) sub-activity models of front-end processes are used to discover the details of existing MNEs' front-end processes, and to discuss their actual strategies and tactics in depth.

The study is designed primarily to identify the factors that affect mistrust and uncertainty in the idea generation process of NPD. To derive maximum value from this investigation, an approach based on triangulation was deployed. This implied the use of a mix of quantitative (a quantitative-oriented survey) and qualitative (interview) tools (Bamberger, 2012; Greene, 2007). A blend of both tools in the study facilitated the derivation of clear and well-delineated results when comparing differences across the three types of functional teams working in NPD in MNEs.

Summary of the Typical Methods Used in Empirical Studies and Methodologies Adopted in NPD Idea Management Studies

The selection of a robust research method is vital to ensure research is fit for its intended purpose and to optimise the reliability of its results. Therefore, the choice of research method is recognised as a crucial technical step in research (Moghimi, 2007). For this reason, this section (a) summarises the methods typically used in empirical studies, and (b) looks at how prior NPD idea management studies have utilised these methodologies, so that this work can adopt accurate methods that suit the purpose of this research.

(a) Typical Methods Used in Empirical Studies

In the majority of social science studies, quantitative-centred surveys, interviews, focus groups, observation studies and case studies are used as core methodologies (Bogdan & Biklen, 1997). This part summarises these techniques and analyses their strengths and weaknesses, which will allow us to consider their suitability for studying NPD idea management.

Quantitative- oriented Survey

The advantage of the quantitative-centred survey is that it implements data collection and analysis speedily, and allows clear comparison between samples with objective numerical information (Choy, 2014; Yauch & Steudel, 2003). However, it is difficult to obtain an in-depth explanation of research results by using the quantitative-centred questionnaire method. For example, they do not provide further information about the factors that affect the answers to questions, and do not necessarily seek the opinion of the respondents regarding issues (ACAPS, 2012; Dudwick et al, 2006).

Interview

Interviewing is the most common data collection format for qualitative research (Jamshed, 2014). Generally, the interview method is considered the appropriate research methodology for data collection concerning human experiences and thoughts related to a specific topic (Kaufman, 1992; Kvale, 1996). Interview, through questions carefully formulated by researchers, can directly approach the respondents' thoughts, memories and ideas, so that researchers are able to acquire defined answers and detailed information (Gillis & Jackson, 2002). The structure of an interview should be carefully designed in order to maximise opportunity for respondents to express their opinions effectively based on their own experiences, without deviating from the research theme and purpose (MacDonald, 2012; Stringer, 1999).

Interview styles can be divided into (1) structured interview, (2) unstructured interview, and (3) semi-structured interview. Each type of interview is classified according to the level and scope of the pre-planned interview question contents (Doody & Noonan, 2013; Holloway & Wheeler 2010).

(1) Structured Interview

In the structured interview, each interviewee receives the same questions, including detailed and clarifying enquiries, in the same way as other interviewees (Corbena, 2003). The advantage of the structured interview is that researchers can quickly and easily code, compare and analyse collected data, by tightly controlling the subject and format of interview questions (Holloway & Wheeler 2010).

(2) Unstructured Interview

Conversely, the unstructured interview often has broad, open questions about the research area, and subsequent questions can vary depending on the answers of respondents (Holloway & Wheeler 2010). While this interview method has strengths in collecting unexpected data that the researchers did not consider, respondents might give information about unrelated topics, which can lead to difficulties in coding or analysing collected data (Ryan et al 2009). In addition, this method can be affected by the subjective prejudice of researchers. Similarly, as it is hard for a novice researcher to instantly understand the key points in a respondent's answers, questions that are not relevant to the research objectives may be posed (Doody & Noonan, 2013).

(3) Semi-structured Interview

The semi-structured interview is an intermediate type, consisting of characteristics from both structured and unstructured interviews, and is the most generally used kind of interview for qualitative research (Holloway & Wheeler, 2010). This approach allows respondents to freely express their opinions and perceptions when compared to structured interviews. However, by constraining the topic of questions so that the content of the response is less likely to deviate significantly from the topic of the study, researchers can acquire reliable and comparable qualitative data (Cohen & Crabtree, 2006). One key disadvantage of the semi-structured approach is that, as seen in unstructured interviews, it is difficult for novice researchers to be sure of the vital contents of an interviewee's answers, and to ask the most important follow-up questions about related issues (Doody & Noonan, 2013).

Focus Group

The focus group method uses the contents of communication amongst respondents in sample groups as the source of key data. Each sample group normally consists of seven to twelve people who have common characteristics in relation to the subject of the research questions (MacDonald, 2012; Marshall & Rossman, 2006). Due to this nature of the format, the focus group method is often alternatively called a group interview (MacDonald, 2012). An advantage of this approach, when all participants of a sample group have experienced similar situations relevant to a particular question, is that they can provide valuable data by eliciting memories from each other and enabling in-depth discussions (Bricki et al., 2007; Marshall et al, 2006). However, depending on the consistency of sample groups and individual make-up of participants (for example, if a sample group has a mix of managers and employees with contrasting power relationships, or if there are people who are not active in the discussion), there is also the risk that the results can be one-sided or biased (Bricki et al., 2007).

Observation

Observation is a qualitative research methodology associated with human behaviour research. Researchers can observe a subject’s (person's) body language, behaviours, and feelings associated with specific research subjects (Pavan & Kulkarni, 2014). Observation relies on researchers to monitor the everyday processes of communities, groups, teams or individual persons, and is often used in consumer experience research, for example in customer journey[3] or shadowing[4] approaches (Alves et al., 2014; Giacomin, 2014). The great merit of this method is that researchers can gain a wide variety of information, beyond that which the researcher expected to gain, and researchers can also gain empirical verification by observing reactions in real time (MacDonald, 2012). On the other hand, the disadvantage of this method is that it is expensive and time-consuming to carry out such experiments (Pavan & Kulkarni, 2014). In addition, as communication with subjects is not allowed during observation, the personal experience and knowledge of the researchers might profoundly affect conclusions drawn from observation (Menter et al., 2011; Yauch & Steudel, 2003).

Case Study

The case study approach is usually conducted to collect data focusing on particular organisations or fields (Choy, 2014; Gable, 1994). By collecting data on specific examples that are closely related to the research topic, researchers can quickly gain a deep understanding of the issues being investigated, and can obtain rich and accurate data (Gable, 1994). The main reason for using a case study as a research method is that the researchers can synthesise findings on a certain phenomenon (or alternatively on a series of cases) related to their organisations or fields, so that the overall context and issues related to their research question can be identified based on reliable prior evidence (Gummesson, 2000; Noor, 2008). Another strength of the case study method is that it can accurately capture the intrinsic or emerging issues of organisational activities, which is useful in environments where the dynamic of organisational activity changes rapidly (Hartley, 2004). However, as samples are selected based on specific conditions (and based on prior research), case studies often face difficulties in terms of generalising the outcomes from the research (Choy, 2014). Also, as case studies focus on exploring actual examples in detail, problems can arise regarding the confidentiality of data when publishing (MacDonald & Walker, 1975).

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[3] "Customer journey" involves capturing key moments or a sequence of touchpoints in customer's routine, to achieve particular objectives (Norton & Pine 2013; Stein & Ramaseshan, 2016).

[4] Shadowing involves the observation of a participant's daily routine in order to understand their life patterns (Martin & Hanington, 2012).

(b) Frequently Adopted Methodology in NPD Idea Management Studies

NPD idea management studies generally aim at gathering interviewee's opinions, or alternatively a sample of (individual and/or organisational) experiences related to specific issues, rather than analysing participants' daily behaviour. For this reason, existing research in NPD idea management tends to use surveys, interviews, focus groups, and case studies as the main methods, rather than observational studies. This is due to the recognised advantages and disadvantages of these methods, as discussed in detail in (a) above.

For example, Song et al. (1998), who performed research on 'employee involvement structure', one of the key issues in idea management studies, used both focus groups and interviews methods in order to identify the most appropriate mix of diverse teams at each NPD stage. They conducted 18 focus group interviews with 69 participants working in US companies, and the average time of each group interview was three hours. In addition, they interviewed each participant after the group interviews. Their research results could be maximised by investigating respondents' experiences using a mix of both group and personal interviewing methods.

Knowledge sharing is also studied as a key topic in idea management research. Lawson et al. (2009), in a paper entitled *Knowledge sharing in interorganizational product development teams*, sent a quantitative survey to 750 participants in order to improve a knowledge-sharing mechanism (process). As they needed objective and clear evidence for developing a knowledge-sharing process, they chose a Likert scale as the main methodology for statistical analysis. Holloway (2009) cited detailed examples of diverse case studies that he has investigated over the years: He implemented multiple case studies for seeking the merits of multidisciplinary thinking that is the core issue of design thinking and idea management.

Selection and Rejection of Empirical Investigation Methods

NPD idea management studies should therefore apply the methods that will provide data that will answer their specific question, and researchers need to consider the purpose of the study and the pros and cons of each approach (Bogdan & Biklen, 1997).

The purpose of this study is to identify the factors that affect mistrust and uncertainty in the idea generation process of NPD, by comparing differences across the planning, design and engineering teams of MNEs. Hence, the study used a combination of quantitative-oriented surveying (quantitative method) and interviews (qualitative method) involving employees currently working in the three types of teams (planning, design, and engineering teams) in Korean MNEs as its main research methods. It was possible to clearly compare the differences amongst the three teams by the use of quantitative-centred survey, while multiple interviews enabled in-depth investigation of the issues and the collection of rich and granular information.

As with other NPD idea management research, as this study aims to explore participants' opinions and experiences rather than analysing the participants' daily behaviour, the observation method was not considered as the main research methodology. In addition, the group interview methodology (focus groups) was excluded, since the interview participants were a mixture of managers and employees who are in a hierarchical power relationship (Korean corporate culture tends to be characterised by a culture of vertical hierarchy). The sample organisations of this study were globally leading companies. There are therefore many restrictions enforced regarding company confidentiality before publication. For this reason, the case study method was also rejected, as it was unlikely to generate sufficient detailed information on multiple cases.

3.2. Development of Research Tools

This study explored a wide range of literature and extracted a variety of key issues with respect to disconnections and misalignments between idea generation and product development activities.
The issues found in the theoretical study provided the basis for configuration of research questions and the creation of questionnaires used in quantitative-centred survey and interviews. The purpose of the empirical study is to examine the difference between existing understandings with respect to idea generation and NPD, and actual, real-world practices. The aim is also to discover the gap in the results between different types of sample groups stage by stage.

Extracting Theories from the Literature Review

The initial theoretical study comprised a multi-theme literature review. A systematic literature review can aid in a synthesis of available evidence of critical issues in NPD processes. It can also emphasise the meaningfulness of the issues found and thus guide the design of empirical studies (Fung, 2010; Moreira et al., 2013). The literature review was established to explore existing ideas relating to the idea generation and development processes of organisations' NPD, and to extract core issues that would facilitate comparisons with the results of the subsequent empirical study. In particular, preliminary reading provided information regarding a critical inquiry about the uncertainty and the data used to stimulate innovative ideas during the idea generation and development process.

Thus, this theoretical study investigated three interrelated main themes and sub-themes in the idea management of NPD, namely factors affecting: (1) front-end innovation and idea generation; (2) uncertainty in early stage of NPD; and (3) usage of data, information and insights within idea generation activities in early stage of NPD.

1) Factors affecting front-end innovation (FEI) and idea generation

- Factors affecting FEI performance
- Design thinking
- Importance of idea quality

2) Factors affecting uncertainty in early stage (ES) of NPD

- Need for idea management in the front end of NPD
- Benefits of a multidisciplinary approach
- Mistrust of the internal relationship

3) Factors affecting usage of data, information and insights (DII) within idea generation activities in early stage (ES) of NPD

- Data measurement for collecting useful information
- Significance of simplifying complex information
- Data, information, and insights that stimulate innovative ideas

Journal Topics and Number of Papers

This study commenced with a simple bibliometrics exercise, one that was aligned with the aims of identifying the significance of efficient idea generation and development in the front-end process of NPD. From preliminary reading, the study examined issues related to five general themes – idea generation, ideas, design thinking, NPD, and front end – from the years 2001 to 2014.

Subsequently, the topic area was expanded via related keywords in the prior reviews so that this study accumulated theoretical knowledge. As a result, the exercise extracted several key issues relating to front-end and idea generation. The reference papers were surveyed through the Google Scholar search engine and SJR[5] and leads were generated on the basis of extracted key words. Iteration of search terms was applied as the exercise expanded. The exercise examined articles (identified as being linked to extracted key issues) in the business and management journals, specifically those that posted an average Q1 level over the past decade (e.g. Journal of Product Innovation Management, Strategic Management Journal, and Harvard Business Review). In addition, the study referred to the articles referenced in the articles in the Q1 level journals.

Table 10 shows the number of times each key theme was referenced in this study. It refers to approximately 560 pieces in the literature, with more than 80% of them being published during the period 1991–2018.

The theoretical study mainly focuses on the themes of 'innovation and design thinking', 'ideas and idea quality', 'knowledge and idea management', and 'research methodologies'.

Table 11 shows the number of times each resource type was referenced in this study, and it mainly refers to quality level 1 journals.

[5] SCImago Journal & Country Rank (SJR) scores journal levels (Q1-Q4) based on the information contained in the Scopus database (Elsevier B.V.). Journals ranked Q1 and Q2 are known for having higher impact factors (IF) than Q3 and Q4 ranked journals (SCImago, 2007).

* Yellow Box: Main years and topics of literature review or main resources / Green Box: The highest proportion of each category

Topic	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2018	n.d.	%
Innovation and design thinking				1	8	28	19		10.0%
Ideas and idea quality	2	2	5	1	15	23	10		10.3%
NPD and front end		1		2	10	19	4		6.4%
Knowledge/Idea management			2		15	22	20		10.5%
Uncertainty		1		5	1	6	6		3.4%
Multidisciplinary approach				8	12	14	5		7.0%
Internal conflicts	1	2	1	12	18	12	2		8.6%
Integration of knowledge		1	1	3	6	4	4		3.4%
Data measurement	2				7	10	7		4.6%
Data to insight					1	5	6		2.1%
Complexity to simplicity		2	4	5	9	14	3		6.6%
Stimulus data			2	3	5	10	17		6.6%
Use of data		1	2	2	6	5	3	1	3.6%
Research methodologies	1	1	2	2	10	23	21	1	10.9%
Korean business				1		4	7	3	2.7%
Other		1		1	5	3	7	2	3.4%
Percentage	1.1%	2.1%	3.4%	8.2%	22.8%	36.0%	25.1%	1.2%	100%
	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2018		

Table.10. Number and ratio of referenced literature: literature years and topic

Types	Conference Papers	Books	SJR Journals				Other (e.g., Web site, Press)	Total
Number	43	96	312				110	561
%	7.7%	17.1%	55.6%				19.6%	100%
Quality Level	-	-	Q1	Q2	Q3	Q4	-	-
Number	-	-	257	46	7	2	-	306
%	-	-	82.4%	14.7%	2.2%	0.6%	-	100%

Table.11. Number and ratio of referenced literature: literature types and quality of referenced journals

Questionnaires Design

The Questionnaires for the empirical study was built based on the key findings from literature reviews. It adopted a triangulation methodology, which is the blending method of using quantitative and qualitative investigation (Webb et al., 1966). In the social and management sciences, cross-validation through mixed methods of collecting and analysing both qualitative and quantitative data (i.e triangulation; Webb et al., 1966) is a well-established technique (Leech & Onwuegbuzie, 2009; Rothbauer, 2008). The validity of this triangulation method is confirmed by improving the accuracy of judgement through the application and combination of several research methods to the same phenomenon and questions (Bogdan & Biklen, 2007; Erina Audrey, 2013; Ndanu & Syombua, 2015). Also, this concept focuses on the notion that qualitative and quantitative methods should be considered as complementary (Jick, 1979). Many scholars have argued that triangulation methods are especially useful for human centred research related to specific circumstances (e.g. Altrichter et al., 2008; Cohen & Manion, 2000). Altrichter et al. (2008) have noted that the triangulation methods often provide a more detailed and balanced picture of the specific situation, while Cohen and Manion (2000) state that triangulation represents an attempt to fully explain the abundance and complexity of issues connected with human or relevant context by exploring themes from more than one perspective. In summary, the mixed method provides rich, high-quality information and improves the validity and reliability of the study (Van Bruggen, Lilien, & Kacker, 2002).

This study uses Likert scales for quantitative-centred survey and adopts a semi-structured approach for the qualitative interviews. The Likert scale is regarded as a useful tool in quantitative research, since it provides a structured overview of participants' thoughts or attitudes in relation to specific questions (Bordens & Abbott, 2002). Also, it is useful for measuring positive or negative tendencies concerning the topics in question (Monteleone & Torrisi, 2012). Therefore, this study uses the Likert scale method to analyse response trends in relation to each specific topic and to compare the trends between different functional teams to identify the salient differences between them. One of the most significant advantages of a Likert scale is that it is a common and proven method that facilitates mathematical analysis. It also generates simple outputs that are relatively easy to understand (LaMarca, 2011). On the other hand, because this scale is unidimensional and provides only limited options, a limit to measuring the true attitudes of respondents is inherent in the results (LaMarca, 2011).

For this reason, this study uses parallel qualitative interviews to complement quantitative material and to address the shortcomings above. The semi-structured interviews were based on a loose structure consisting of open-ended questions that include the exact topics to be explored so that those involved can discuss and express more detailed ideas relevant to the subjects (Britten, 1995). This method enables information providers to express opinions and perceptions relatively freely and from their own viewpoints; also, the conversation contents do not deviate much from the inquiry domain, so semi-structured interviews can provide reliable and comparable qualitative data (Cohen & Crabtree, 2006). Therefore, the empirical study adopts semi-structured interviews to obtain clear results through well-organised kernel questions, as well as to become aware of additional issues through conversations with interviewees.

Research Questions

The key objective of the empirical study was to comprehend what MNEs actually do in practice, and what issues they face in their idea generation activities. So, the following research questions (RQs) were created (iteratively) as a means of identifying the issues that form the foundation of opportunities for enhancing the idea generation activities of industrial organisations.

RQ1: What are the current nature of the idea generation processes and the importance of idea quality in ES of NPD processes?

Sub-issues examined to address RQ1:

- Nature of the idea generation processes of MNEs
- Importance of idea generation activities and idea quality in ES of NPD by MNEs
- Factors considered by each expert group when defining idea quality

RQ2: What are the reasons for initiating new projects, and what is the nature and level of involvement of various functional groups in the idea generation phase?

Sub-issues examined to address RQ2:

- Reasons for starting NPD
- Importance and effectiveness of each expertise group’s involvement in generating ideas
- Frequency of each expertise group’s involvement in the idea generation stage

• Primary activities of each expertise group during idea generation and development phases

RQ3: What are the factors that affect uncertainty when generating and developing new ideas?

Sub-issues examined to address RQ3:

• Understanding the specific stages at which each expertise group encounters uncertainty in the idea generation and development phase
• Reasons for encountering uncertainty while generating new ideas
• Importance and effectiveness of communication between the expertise groups in reducing the level of uncertainty when generating ideas

RQ4: What data types, resources, and formats are typically used in stimulating or generating new ideas?

Sub-issues examined to address RQ4:

• Nature of MNEs' use of data and information when generating ideas
• Nature of use of data, information, and insights that are typically used by each expert group in order to stimulate generating ideas
• Frequency of the use of the data, delivered from internal research division, by each expertise group when generating new ideas

Figure 14 shows how the research questions are built on the theory extracted from the literature review, in order to explore real-world idea generation and development activities.

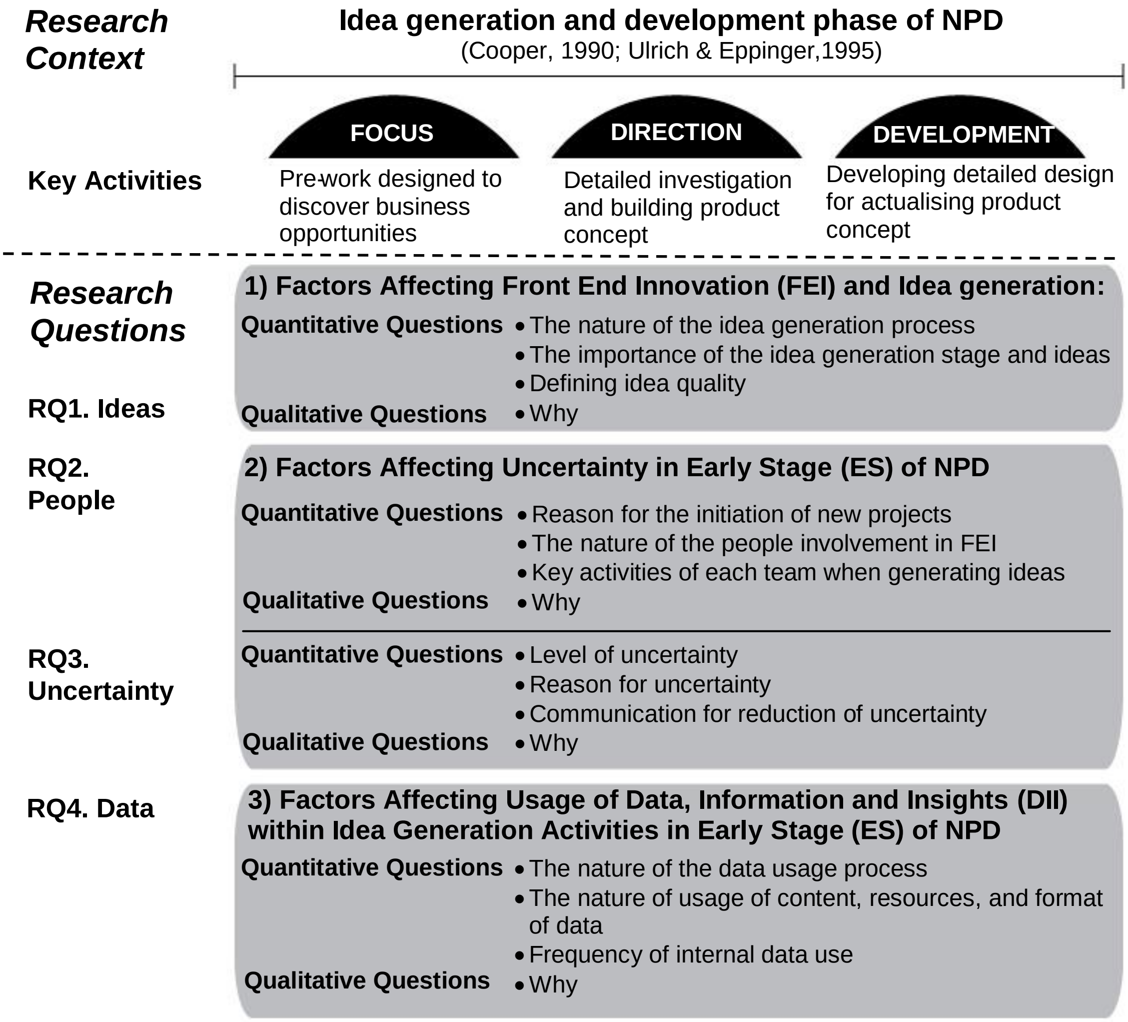


Figure 14. Exploratory research framework: extraction of theory for designing RQs

3.3. Implementation of the Study

The study comprises a large body of empirical research. It involved three sets of interviews and a survey with various expert teams from two mainstream groups in industrial MNEs (research-centred teams [planning], and practice-centred teams [design, engineering]) from four leading multinational companies in the smart electronics and automobile industries in Korea. This was done because undertaking interviews with people who have the same or divergent backgrounds potentially presents opportunities to identify common or different perceptions of the same issues (Denscombe, 2014; Krueger, 2014).

The questions for the empirical studies were designed to examine specific issues and needs relating to the achievement of innovative outcomes for MNEs through successful idea generation activities in the front-end phase of NPD (see Appendix 29).

The pilot study was implemented with seven participants from planning and design teams, and was designed to facilitate a better understanding of the overall context of recent idea generation practices in MNEs, in order that subsequent interviews might accurately address core issues related to the early period of NPD. The main study involved interviews and surveys with 34 participants from the planning, design, and engineering departments of the four sample companies, and the questionnaires were developed on the basis of findings from the previous pilot study. The primary goal of the main study was to discover the key factors and opportunities applicable to actual idea generation practices during NPD at MNEs. A validation study was performed with 12 employees from planning, design, and engineering teams from the sample companies. The validation study explored in-depth information regarding the findings from the main interviews by referring to respondents' personal examples in order to better understand the factors causing difficulties in idea generation activities in front-end NPD and to identify new opportunities.

Selection of Companies and Participants

To investigate opportunities regarding rapid business growth in environment which mix globally-used NPD processes and local business culture, this study focused on companies influenced by Korean management culture. It is because South Korea has one of the world's fastest-growing economies and Korean MNEs achieved global success in rapid economic growth (Almansoori, 2014; Amsden,1993; Ritz & Bevins, 2012) (see p.3), therefore, the opportunities identified can contribute to global industrial firms that pursue rapid growth and success of NPD in the global market.

An initial target number of interviewees for the main study was 60 (20 each in the planning, design, and engineering teams of the four sample companies), while that of the validation study was 12 (four each in the same configuration). The sample focused on the primary NPD teams in Korean industrial MNEs that (1) sell widely in the global market and cover all five continents (to avoid MNEs selling products in only particular region of the world); (2) average being in the global top ten in the revenue ranking of their industry sectors for the last decade (to strengthen the contribution of this research to the studies regarding actual industrial practice); and (3) operate planning, design, and engineering teams as primary divisions of NPD projects (to obtain clear and meaningful results by examining multiple answers acquired from environments with the same team componentry)

The overall response rate of the main study was 57%, comprising 53% from consumer electronics, 47% from automobile products, as well as 29% from the planning teams, 50% of the design teams, and 21% from the engineering teams. Also, the overall response rate in the validation study was 100%: 58% in consumer electronics and 42% in automobile products, along with 33% in planning, 33% in design, and 33% in engineering teams. The range of the interviewees' experience in the company is varied, from 5 to 23 years. However, except for directors and managers, 76% of total interviewees have between 5 and 10 years of working experience.

Scoping Empirical Studies

The three types of empirical studies' sample groups (planning, design, and engineering teams) were selected from four industrial MNEs that operate in the smart electronics and automobile product sectors. They vary in numbers of employees from 75,000 to 325,000 and in revenue from £37 million to £133 billion per annum. Also, their global rankings of turnover range from 1 to 11 in their industry sectors for the last decade (2007 to 2017) (Fortune, 2017). Also, the pilot study confirmed that the four sample companies commonly operate their planning, design, and engineering teams as the primary divisions for NPD activities.

Company A leads the smart electronics industry sector, employs approximately 325,000 staff members internationally, and has a recent annual revenue of approximately £133 billion. This company has a more detailed NPD schedule and a more solid reporting system compared to the other sample companies. In particular, its strength is the speedy collection and analysis of current data by internal research expertise groups located around the world. Despite the vast amount of money the company invests in research, the findings of the current study demonstrate that its employees do not use research results effectively for idea generation.

Company B also operates in the smart electronics industry sector, employing around 75,000 staff members internationally, and has recent annual revenues of approximately £37 billion. The company has a more flexible NPD process compared to company A: the team often performs detailed idea generation and development activities based on its manager's direction. In addition, employees have frequent opportunities to express their opinions within their team, since the company has a comfortable and integrated relationship between managers and staff. However, the company also demonstrates a high level of interdepartmental conflict in the idea development process.

Company C operates in the automobile industry sector, employs about 225,000 staff members internationally, and has recent annual revenues of approximately £126 billion. Its NPD process is similar to that of company A, with detailed and specific NPD activities and time schedules. Furthermore, it prepares definite, objective regulations for each decision, so that ambiguous decisions are avoided and the burden on decision-makers is reduced. However, its employees expressed concern that the specific and detailed rules might be an obstacle to generating innovative ideas and that they may create delays in NPD, since decision-makers need to meet rules and obtain agreement, even in less important stages of the process.

Company D operates in the automobile industry sector and employs about 220,000 members of staff internationally, with recent annual revenues of approximately £61 billion. Compared to the other three sample companies, it is characterised by a relatively flexible NPD schedule, with the director or manager demonstrating authority. Although this flexible schedule enables the NPD project to progress rapidly, subjective decision-making by directors is perceived as a source of high levels of employee uncertainty.

In summary, companies A and B operate in consumer electronics products, and C and D operate in the automobiles sector. In terms of process, companies A and C demonstrate slightly more formal methodologies with respect to NPD schedules and decision-making than B and D. However, there was no significant difference demonstrated in the interview results between the four sample companies in terms of process and approach, and the study below shows a meaningful difference only between expertise groups involved in idea generation and NPD.

Implementation of Empirical Studies

This study conducted face-to-face mode for the interviews of the main and validation studies, and the pilot study was implemented by telephone and email. Many authors (e.g. Holt, 2010; Novick, 2008; Oltmann, 2016) stated that face-to-face interviews are a staple method in qualitative research. Also, they express concern that telephone mode can undermine the quality of interviews, or that the positive utility of the telephone mode compared to face-to-face mode remains largely unexplored.

On the other hand, in several studies regarding the use of face-to-face versus telephone interviewing modes over the last three decades, interviewing via telephone (as well as other virtual methods such as skype or email) has achieved wide recognition as an appropriate mode for qualitative interviews as a result of its locational merits (Oltmann, 2016). These studies have revealed that multiple interviewing methods including telephone or virtual modes can be selected as an appropriate method if they are congruent with the aims of the research. Therefore, researchers can choose appropriate modes based on negotiation between both interviewers and respondents through examining the interview context (Fontana & Frey, 2000; Ryan et al., 2009).

For this reason, this study has utilised the face-to-face mode for the main and validation studies: this offers the benefit of detailed information from interviewees' answers and creation of awareness of additional issues via the conversational setting. For the pilot study, the face-to-face mode has been substituted with a mix of the telephone and email modes: this constitutes an appropriate method to obtain overall context of recent idea generation practices in MNEs within a convenient interview environment for both interviewer and respondents.

At the beginning of each interview, the researcher sent an interview cooperation letter to potential interviewees with a description of the research context and interview purpose via email. Once the potential interviewees replied with agreement to interview, interview date, venue, and time was established on the basis of mutual convenience.

In pilot study, all interviews with each of the seven respondents were implemented via telephone (and email for some additional answers). Also, the interview questionnaire was sent to the pilot interviewees by email before starting interviews.

Each pilot interview took around 30 to 40 minutes, and consent was gained prior to commencement of the interview. Furthermore, 29% of total pilot study's respondents offered their additional opinions via email after phone interview.

All main interviews with thirty-four interviewees were conducted in face-to-face mode. 74% of the main interview respondents invited the interviewer to their office or visitor conference rooms in their company buildings, and 26% of the main interviews were implemented in cafés in a lobby or nearby building when conference rooms are not available. Interview time varied from 60 to 90 minutes: again, consent was secured prior to interview commencement.

All validation interviews with twelve respondents were also performed in face-to-face mode. 67% of the validation interviews were undertaken in visitor conference rooms in informant's buildings, and 33% of the validation interviews were undertaken in nearby cafes. Each validation interview lasted between 40 and 60 minutes. Respondents for the three sets of interviews (pilot, main and validation) were kindly cooperative and offered flexibility in the location and duration of the interviews. All were completed within the agreed time.

Limitation and Encountered Issues

As each participant of interviews was an employee of leading MNEs in the competitive industrial market, they were cautious in being interviewed by outsiders about their NPD processes and product-related information.

Therefore, since each company had strict rules on interviews with outsiders, it was not easy to secure interview consent from them, and it took a longer time than expected to persuade them to have interviews. As a result of busy schedules and business trips, discussion regarding date and timing of interviews was needed at least two months prior to the event.

However, once interviews had begun, co-operation and the interviewees' maximum assistance were ensured, as they had a great interest in the current NPD issues they faced.

Ethical considerations

The research has designed based on the academic ethical guidelines. This study provided interviewees with a written and telephone explanation on the purpose, contents, and method of the interviews at every stage of the process, and sought written consent in relation to interview methods, contents and publishing. All interview data were handled in confidence and stored securely in accordance with data protection legislation. Some answers relevant to companies' confidential information were adjusted or removed after discussion with interviewees.

Anonymity was discussed at the beginning of the interview; interviewees who wished to remain fully anonymous were given pseudonyms, and others were referred to via use of initials or their full name (in line with participants' request). In the case of recording voices or taking photos, the study acquired the agreement of participants before commencing the interview. All data were stored safely and securely by the researcher during the research period. No third parties have access to any data.

3.4. Data Analysis

The interview phases of the research were designed to provide an opportunity for triangulation of results (i.e. a systematic and careful blending of quantitative and qualitative materials). The study used primarily the Kruskal-Wallis test for analysing the results of the quantitative survey, and a content-analysis method for the qualitative interviews. Wilcoxon's Signed-Rank test was also used to aid in interpreting the results of the main study.

For quantitative data analysis, the Wilcoxon Signed-Rank test was utilised in SPSS Software: this permitted identification of the tendencies in each group's preferences. Also, it permitted examination of the highest and lowest means between different types of groups and the comparison of results between different groups. Subsequently, the meaningfulness of the gap was determined via the statistical analysis of the Kruskal-Wallis test. Both the Kruskal-Wallis and the Wilcoxon Signed-Rank tests are non-parametric tests that can be used with small and unequal sample sizes (Charles, n.d.; Schmider et al., 2010). The Kruskal-Wallis test is often used when comparing more than two samples of equal or different sizes (Corder & Foreman, 2009; Kruskal & Wallis, 1952), while the Wilcoxon Signed-Rank test is used to determine if the medians of the samples are equal to a specified value or not (Kamilaris et al., 2015; Lowry, 2014). Also, comparing means is one of the most common methods of an analysis of data in experimental or observational studies (Nelson et al., 2005).

Qualitative methods have been regarded as a central element of social and management research for many decades and are used very extensively in contemporary studies. They provide the benefit of enabling researchers to explore issues and research questions actively and creatively by critical and reflective investigation of the findings in the data (Mason, 2007). The main activities within qualitative analysis include identifying, coding, and classifying patterns that are discovered within the data (Michelle, 2012). This study deployed a content-analysis method for the interrogation of qualitative data. The approach offers objective, systematic inferences through the identification of specified characteristics within answers (Holsti, 1969, p.14). By investigating reasons that underlie the marked numbers in a Likert survey (delivered by quantitative survey) during conversations with sample interviewees in qualitative interviews, research results can be expanded, enriched and interpreted with greater rigour.

3.5. Discussion and Conclusions

The main aim of the discussion in this thesis is to investigate the level of alignment between current theory and understanding with respect to central elements of NPD activity, and the actual, day-to-day practice of NPD that is revealed by empirical study. The research provides distinctive new knowledge by identifying the conformance or contradiction between existing theories and emerging issues in real practice. It also strengthens existing knowledge via detailed investigation with respect to actual issues that MNEs face when undertaking NPD.

This study concludes with a narrative summary of the research and the key findings. The study’s contributions and limitations are also described, as well as opportunities for relevant research.

3.6. Reflection and Summary

This study used systematic blending of methods as its key approach to research. On the macroscopic level, the thesis attempted to identify new possibilities by integrating existing issues identified in a theoretical study with current issues discovered through an empirical study. At the micro level, the empirical study implemented a synthesis method of using quantitative and qualitative materials and analysis, and used semi-structured qualitative interviews to both obtain clear answers to key questions and generate awareness of additional issues through open-ended questions.

This integrating methodology was developed on solid theoretical grounds, and represents an appropriate approach for a study that focuses on design thinking, wherein the synthesising of disparate elements is a core characteristic.

Also, by selecting methodologies for the study of Korean MNEs idea management, this section also provided good guidance for how to consider and select which methodologies to use for research of idea management in MNEs, and particularly for those cases that target global markets but have a local business culture.

4. Findings

Introduction

This chapter introduces the results of an empirical study that has been designed based on the investigation presented in the previous literature review chapter. The empirical study consists of three interview-based activities: 1) pilot study, 2) main study, and 3) validation study. The learning and results from each study helped to contribute to design and development subsequent activity.

The pilot study focused on comprehending the recent MNEs' idea generation processes of NPD, and discovering a range of initial emergent issues.
Building upon the learning from the pilot study, the main study centred on identifying the significant issues affecting mistrust and uncertainty during the actual NPD practices of MNEs. In particular, the main study conducted a mix of quantitative surveys and qualitative interviews to investigate tendencies in these issues in-depth between three sample groups. It thereby helped to identify specific factors causing mistrust and uncertainty within cross-functional tasks in NPD.
The validation study concentrated on confirming or disconfirming the results of the main study. Validation interviews generated in-depth information that provided insight into the emerging factors affecting mistrust, uncertainty and opportunities in the sample MNEs' NPD idea generation systems.

In the previous studies of NPD and the front-end phase, many researchers focused on dissimilar characteristics and cooperation between marketing and R&D teams (e.g. Griffin & Hauser, 1996; Song et al., 1998; Vissers et al. 2002). For this reason, this study also concentrated initially on the two types of teams as sample groups for empirical study. From the pilot study findings, this study subsequently identified that three main teams – planning, design, and engineering – lead NPD projects in recent MNEs. Hence, to acquire practical insights to apply to actual idea generation performance, members of these three teams were selected as the interview sample groups for the main and validation interviews. The interview questions were divided into four sub-themes, which reflect key information identified from the literature review:

A. Ideas and the Nature of Idea Generation Process

B. NPD Initiation and People Involvement

C. Uncertainty in Idea Generation

D. Data, Information and Insights (DII) that Stimulate Generating Ideas

This empirical study has found several key issues and opportunities that have the potential to contribute to reducing mistrust and uncertainty in the NPD idea generation practices in the MNE samples. As a result, the final outcomes of this chapter discovered a meaningful gap between three sample teams on perspectives, concept-sets (i.e. a series of approaches and perceptions when collecting and analysing data in order to acquire insights into the idea generation) or roles when generating ideas. Also, it identified opportunities for reducing the gap in order to synthesise different languages (i.e. perspectives and concept-sets) among diverse expertise groups.

4.1. Pilot Study

The pilot study, which was conducted with seven interviewees from planning and design teams of the sample MNEs, had two main purposes. The first was to understand the participants' level of knowledge and terminology about NPD and eliminate any confusion relating to the nature of the proposed questions, terminologies and language that might impact on the main study. From the pilot study, it was confirmed that all of the teams had a good understanding of the terms NPD, front end, and idea generation and their meanings. However, 86% of the interviewees had difficulties in defining actual activities aligned to recognised theoretical NPD models. Specifically, there was confusion in linking the discovery and scoping stages in MNE samples, as the interviewees perceived them both to be part of the same stage, focusing on market context or seeking opportunities (see Figure 15).

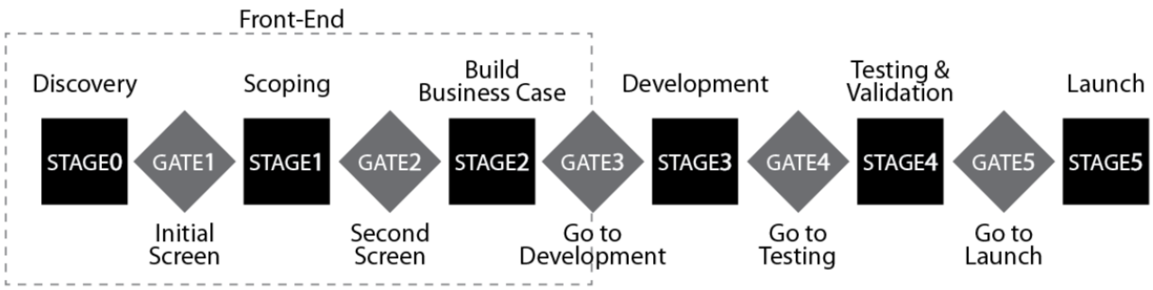


Figure 15. NPD process model and front-end phase (Cooper, 1990)

The learning from the pilot study led to a simplification of terms of the NPD stages within the interview questions, so that the interviewees could better understand the questions and communicate their responses more effectively. Furthermore, the pilot study led to the consideration of expanding the research range from front-end stages to development stage (STAGE.3 of Cooper's NPD model, 1990; see Figure 15); this was because designers mentioned that they are less involved in front-end stages, whereas they actively develop ideas in the development stage. For this reason, this study adjusted terminologies, and divided the front-end and development stages into three stages: focus, direction, development (STAGE.0 to STAGE.3 of Cooper's NPD model, 1990; see Figure 15), as illustrated below (see Figure 16). These definitions were then better aligned to internal definitions and languages with the sample MNEs.

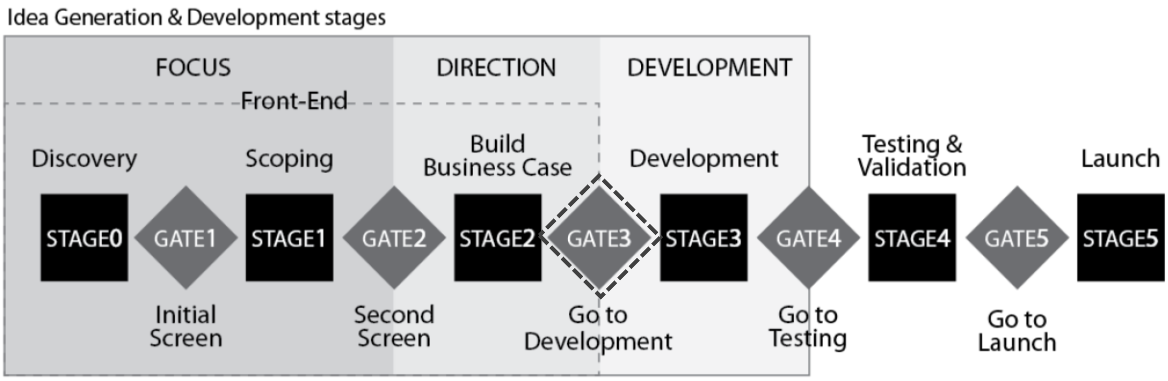


Figure 16. Three stages of NPD front-end and development phase (Cooper, 1990)

The second intention was to gain a rigorous understanding of several key factors that affect difficulties in the idea generation stage of NPD derived from the literature review process.

The factors were examined via the following four key themes extracted from literature reviews: (a) ideas and the nature of idea generation process, (b) NPD initiation and people involvement, (c) uncertainty in idea generation within cross-functional NPD tasks, and (d) data, information and insights that stimulate idea generation.

From the pilot interviews, the following key information has been found (see Table 12).

Theme	Key Findings
A. Ideas and the Nature of Idea Generation	• Idea generation phase is very important in NPD performance as the main concept and direction are decided during the stage, and the direction impacts on later stages
	• Idea generation and development stages normally occupy 50% of total NPD period
	• Quality of ideas is more important than quantity of ideas
	• Companies have own formal NPD processes
	• Defining idea quality is usually affected by decision-makers
B. NPD Initiation and People	• NPD is typically initiated by market trend change
	• Design team believes that design and engineering teams are insufficiently involved in idea generation phase activities
	• Planning team typically leads the idea generation stage, and design and engineering teams are mainly involved after the idea generation phase
	• Data analysis is mainly conducted by planning team for setting NPD concept
	• Designers are often unsatisfied with the NPD concept and its direction
	• The relationship between planning and other teams seems hierarchical rather than horizontal relationship (collaborative teams)
	• The methods of generating and developing ideas are significantly different between design and planning teams

C. Uncertainty in Idea Generation	• Level of the involvement and responsibility of NPD affects the level of uncertainty
	• Reason for Uncertainty: Planning team works under pressure to meet company's business goal, since they lead the idea generation phase and build main concept
	• Reason for Uncertainty: Designers are usually asked to create distinctive ideas within emotional attraction or novelty when developing NPD
	• Designers can reduce their level of uncertainty while talking to the engineering team as practical problems can be removed
	• Planning team asks for numerical and logical evidence from the design team, who more typically work using personal experience and intuition
	• Decision-makers and planning teams in MNEs mainly consider the most logical and predictable ideas to reduce uncertainty and avoid risk
D. Data, Information and Insights (DII) that Stimulate Generating Ideas	• There are no formal processes for using data
	• Consumer research data is the core data used for generating ideas
	• Planning team usually relies on internal research data, while design team generally collects information from web search engines
	• Planning team mainly uses text data, whereas design team generally uses images and video data
	• Design team generally receives planning team's research data, but typically they do not directly use these materials for generating ideas

Table 12. Summary of findings of pilot study

A. Ideas and the Nature of the Idea Generation Process

According to the pilot interview participants, idea generation and development activities are regarded as a core part of their companies' NPD and it takes a relatively long time to implement, generally occupying around 50% of the total time allocated to NPD. All of the respondents answered that their companies had their own idea generation systems, and that defining idea quality was largely affected by decision-makers. Furthermore, 86% of respondents indicated that idea quality is more important than quantity.

The pilot study has helped to better understand the correlation between the idea generation processes and the quality of ideas within NPD processes of the sample MNEs. These learnings have then helped to underpin the development of the main study questions (nature of the idea generation process, the importance of idea quality in NPD, and perspectives of idea quality criteria).

B. NPD Initiation and People Involvement

This pilot study found that most of the interviewees have common views on the starting point and the underlying reason for initiating NPD activities. From the total sample, 86% of interviewees indicated that NPD is generally undertaken when market trends change. While interview results on the previous theme (A. Ideas and the Nature of the Idea Generation Process) did not show significant dissimilarities between the planning and design teams, some noticeable differences appeared in the results about people involved in the idea generation stage. Firstly, the actual level of involvement in the idea generation and development stages was significantly different between the planning and design teams. Participants in both teams commonly agreed that the planning team's involvement is typically very high in the idea generation stages, and vice versa in the development stage. Secondly, both sets of interviewees were aware of dissimilar perspectives and insights between the teams when generating ideas. Members of the design team in particular observed that they are often dissatisfied with the NPD concept established through the planning team's insights.

The pilot study results revealed the need to discover the correlation between the different levels of the teams' involvement and the level of idea generation performance and outcomes. On this basis, this research developed a set of questions for the main study, relating to the different levels of involvement of each team in each stage of ES NPD, and each team's opinion about their involvement.

C. Uncertainty in Idea Generation

In the pilot study sessions, both planning and design teams disclosed a high level of uncertainty when their own team's level of involvement in the NPD process is high. For example, the planning team indicated much uncertainty when generating an NPD concept; similarly, those in the design team said that they experienced the same uncertainty as well when generating practical ideas. In addition, the pilot study found that both teams were aware of the contrasting language used between themselves. The design team described feeling uncertain when talking with the planning team as compared to the engineering team, as the planning team frequently asks the designers to show logical evidence of their ideas. On the other hand, the planning team said that, although many of the ideas from designers are unique, the most logical and predictable ones should be selected in MNEs in order to reduce uncertainty and avoid excessive risk. Based on the learning from the pilot study, the main study questions relating to uncertainty within idea generation activities were developed (i.e. the different level of uncertainty between diverse expert teams, the reasons for uncertainty in the idea generation stage, and the effect of feedback exchange on the reduction of uncertainty).

D. Data, Information and Insights (DII) that Stimulate Generating Ideas

All of the respondents in the pilot study cited an absence of pre-determined and/or formal methodology in the use of data. Also, all respondents agreed that the main focus was on consumer research data when generating ideas. However, the method of using data revealed a gap between the planning and design teams. While planners frequently use in-house research data (internal data) in text format (Factual and Refined Data), designers prefer to collect data in image format from web search engine sites (Creative Catalyst). Furthermore, all design team respondents indicated that they do not use their company's in-house research data very often when generating ideas. The pilot study learning provided a series of insights that have helped to explore in more detail the differences between teams in how they use data and how these differences impact on the idea generation activities in front-end NPD.

From the pilot study, it was possible to identify that the research- and practice-based teams differ significantly in their idea generation activities. In addition, the results also showed that each team's role and level of involvement changes significantly after the direction stage (after GATE.3 of Cooper's NPD model, 1990; see Figure 16). Furthermore, the interview results confirmed that engineering teams are among the primary teams in NPD projects of MNEs; therefore, to enrich the study, the main study was expanded to include them.

4.2. Main Study

The focus of the main study is identifying the emergent factors that typically affect idea generation tasks in the front-end phase, as well as discovering opportunities for improving the outcomes of NPD in MNEs. Specifically, building on what was learned in the pilot study, the main study conducted a comparative study of emerging issues between the three functional teams (planning, design, and engineering) in recent NPD of MNEs.

In the main comparison studies, different roles, perspectives, and methods of obtaining insights were found among the three sample teams. In addition, this main study identified that these differences affect mistrust and uncertainty when generating ideas. The emerging issues were investigated via the following four key themes extracted from literature reviews:

4.2.1. Ideas and the Nature of Idea Generation Process
(Relating to Interview questions section A, see Appendix 29)

4.2.2. NPD Initiation and People Involvement
(Relating to Interview questions section B, see Appendix 29)

4.2.3. Uncertainty in Idea Generation
(Relating to Interview questions section C, see Appendix 29)

4.2.4. Data, Information and Insights (DII) that Stimulate Generating Ideas
(Relating to Interview questions section D, see Appendix 29)

The main study was implemented with a sample of thirty-four participants from the planning team (10), design team (17), and engineering team (7) of four industrial MNEs.

A triangulation methodology was adopted (mixing quantitative and qualitative research methodologies, Webb et al., 1966), since this blended approach to conducting research enhances results through complementing the limitations of its own parts (Bamberger, 2012; Carvelho & White, 1997; Greene, 2007; Jick, 1979). Furthermore, the combination of quantitative and qualitative interview techniques enables identified issues to be described more fully from multiple viewpoints (Cohen & Manion, 2000). The quantitative questions were designed using the

‘Likert scale’, offering an overview of participants' opinions regarding a specific theme (Borden & Abbott, 2002; Monteleone & Torrisi, 2012). Also, ‘non-parametric statistic analysis’ was used in order to examine the results of unequal sized samples across the different functional teams (Charles, n.d.; Schmider et al., 2010).

In the qualitative questions, a ‘semi-structured’ methodology was performed in order to identify the reasons for the results of Likert scale survey and to obtain additional issues via conversations with the interviewees. In addition, ‘content analysis’ was used as a method of analysis of the qualitative interviews for investigating the specific characteristics and meanings from the answers of interview participants (Holsti, 1969).

The findings of the pilot study showed that the level of involvement of research- and practice-based teams flips after the direction stage (at GATE.3 of Cooper’s NPD model, 1990). The planning team’s involvement is typically higher than that of the practice-based team in the focus and direction stages, and vice versa in the development stage (see ‘Transition point’ at Figure 17).

To systematically explore the emerging issues related to different team’s roles and involvement in cross-functional NPD tasks, the main study adopts Cooper’s NPD model (1990) and Ulrich and Eppinger’s (1995) sub-activity models of the front-end phase (see p. 37 and 38).

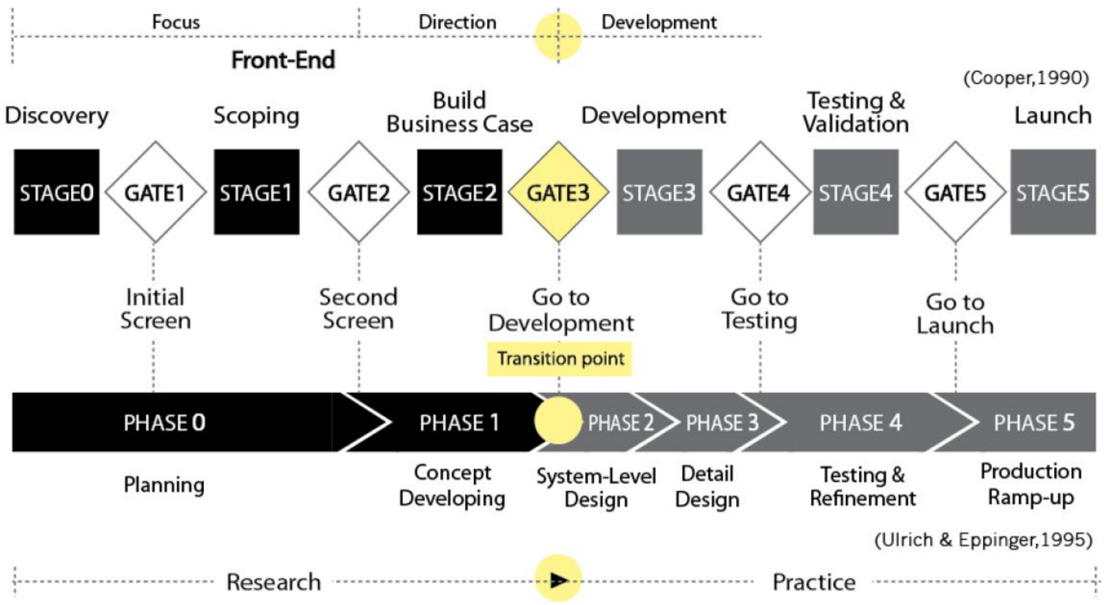


Figure 17. Transition point from research to practice in ES NPD in MNE sample

4.2.1. Ideas and the Nature of Idea Generation Process

The following colour codings from Table 13 to 75 were utilised in each quantitative and qualitative activities, to indicate the emergent patterns from interview data more effectively: yellow indicates the emergent key factors related to each question; green signifies the highest proportion of answers in a category of the quantitative study or the significant findings in a category of the qualitative study; and red designates the lowest proportion of answers in a category.

The main study was designed to investigate issues and opportunities related to the ideas and idea generation processes in recent NPD practices of MNEs.

Hence, it focused on: (1) exploration of the nature of recent idea generation and development systems to help clarify the issues emerging from the recent system, and (2) discovery of employees' thoughts about the level of importance of the idea generation stage and of idea quality and quantity in NPD. Also, (3) it compared the factors that each functional team uses when defining the quality of ideas, in order to examine the commonalities and differences between them.

(1) Nature of idea generation process

(1-1) Length of the idea generation / development process (Interview Q: A.1)

In the pilot study, the sample participants indicated that the idea generation and development stage generally occupied approximately 50% of the total time taken up by the NPD process, and it is regarded as a core part of their companies' NPD. In the main study, 94% of the total participants agreed with the pilot study's outcome (see Table 13). The findings of the main study confirmed that, although the absolute duration of the actual time period of NPD is different depending on types of products, the proportion of the time spent on the idea generation and development stages is generally similar at around 50% of total NPD duration.

* Figures are percentages.

Function	Idea generation and development period is ~50% of total time of NPD process			Total
	Agreement	Disagreement	Others	
Planning	100	—	—	100
Design	94	—	6	100
Engineering	86	—	14	100
Total	94	—	6	100

Table 13. Agreement on the length of the idea generation and development phase in NPD

(1-2) Nature of the idea generation process (Interview Q: A.4)

Two key factors emerged relating to the nature of the idea generation processes. First, all of the sample respondents indicated that their respective companies have idea generation processes that are formal, structured, and team-based (see Table 14): The process usually runs under the official schedules given in advance and operates within a top-down structured process -— the planning team decides on the NPD concept and the design and engineering teams actualise it. In addition, idea generation tasks are normally undertaken within a team-based environment. However, 82% of total respondents in the main study indicated that detailed schedules are often adjusted depending on projects or on managers' own working style (planning: 70%, design: 88%, engineering: 86%) (see Table 15). Secondly, the findings showed that the design team frequently conducts individual-based tasks in the idea generation stage, compared to the other two teams (see Table 14 and Appendix 1).

Scale
1. Never use 2. Low use 3. Slightly use 4. Moderately use 5. Use fairly often 6. Always use

Function		Formal	Informal	Structured	Unstructured	Individual Based	Team Based
Planning	Mean	5.00	3.40	5.00	3.60	3.60	5.90
	Standard Deviation	0.471	0.516	0.667	0.516	0.699	0.316
Design	Mean	4.82	3.00	4.65	3.24	5.00	5.35
	Standard Deviation	0.636	0.866	0.606	0.831	0.866	0.606
Engineering	Mean	4.86	3.14	4.86	3.14	4.00	5.57
	Standard Deviation	0.690	1.069	0.690	0.690	1.291	0.535

Table 14. Overall nature of the idea generation process

Function	Content	Frequency (%) Times Mentioned
Planning	• Company has formal, top-down, structured NPD process with regular meetings or events	100
	• Detailed schedule is organised by each manager	70
	• Company provides detailed schedule	30
	• Company is trying to change the top-down structure (e.g., selecting ideas from internal competition or making study groups)	20
Design	• Company has formal, top-down, structured NPD process with regular meetings or events	100
	• Detailed schedule is organised by each manager	88
	• Designers usually work individually when making idea sketch for actualising ideas	35

	• Company is trying to change the top-down structure (e.g., selecting ideas from internal competition or making study groups)	24
	• Company provides detailed schedule	12
Engineering	• Company has formal, top-down, structured NPD process with regular meetings or events	100
	• Detailed schedule is organised by each manager	86
	• Company provides detailed schedule	14

Table 15. Qualitative study findings on the nature of the idea generation process

(2) Importance of the idea generation stage and ideas

(2-1) Level of importance of the idea generation stage (Interview Q: A.2)

Eighty-two percent of the main study sample perceived the idea generation stage in front-end NPD to be very important (planning: 90%, design: 82%, engineering: 72%) (see Table 16). They universally felt that the front-end phase is the decisive stage in the NPD process: According to them, if the wrong product concept is selected, it would be difficult to adjust the product direction after it has been chosen (planning: 90%, design: 76%, engineering: 86%) (see Table 17). Specifically, the design and engineering teams were concerned about erroneous decisions in the front-end phase. According to 42% of design and engineering team interviewees from the main study, erroneous decisions have a potentially large effect on the later stages in which design and engineering teams are typically largely involved (design: 41%, engineering: 43%) (see Table 17).

* Figures are percentages.

Function	Very Important	Fairly Important	Important	Slightly Important	Low Importance	Not important	Total
Planning	90	10	-	—	—	—	100
Design	82	6	12	—	—	—	100
Engineering	72	14	14	—	—	—	100
Total	82	9	9	—	—	—	100

Table 16. Level of importance of the idea generation (front-end) stage in NPD

Function	Content	Frequency (%) Times Mentioned
Planning	• It is difficult to adjust the product's main contents or goal after product concept is set	90
	• Although generating ideas is important, actualising the ideas in the later stage is a big challenge as well	30

Design	• It is difficult to adjust the product's main contents or goal after product concept is set	76
	• Although generating ideas is important, actualising them in the later stage is a big challenge as well	47
	• Selection of the wrong NPD concept affects the later design- and engineering-based stages	41
	• Well-established direction in the front-end largely affects passion for a project	29
Engineering	• It is difficult to adjust the product's main contents or goal after product concept is set	86
	• Wrong NPD concept affects the later practice-based stages	43
	• Although generating a quality idea is important, actualising it in the later stages is also big challenge	43

Table 17. Qualitative study findings on the importance of the idea generation stage

(2-2) Idea Quantity vs. Idea Quality (Interview Q: A.3)

The pilot study established that 86% of respondents in the pilot study agreed that they focused on developing quality ideas more than on the quantity of ideas when attempting to generate new ideas.

The main study confirmed this view; however, the actual mean of both idea quantity and quality were high (i.e., more than 5.0, see Table 18). This indicates that the interviewees in the main study recognised the high importance of the quantity of ideas for creating ideas as well as their quality. Ninety-one percent of the sample in the main qualitative interview showed that high-quality ideas are a crucial factor when attempting to develop innovative new products that distinguish them from competitors (planning: 100%, design: 88%, engineering: 86%) (see Table 19). Forty-one percent of main interview participants aligned with Osborn's (1953) view that idea quality follows idea quantity (planning: 50%, design: 35%, engineering: 43%). In other words, they believed that the more ideas they produce, the more likely they are to find high-quality ideas (see Table 19).

Of the design team's respondents in the main study, 35% indicated that the idea generation method, whether quantity-oriented or quality-oriented, was usually dependent on the manager's management style. For this reason, 35% of designers interviewed in the main study expressed their concern about being overly focused on idea quantity when attempting to generate new ideas. This suggests that these designers are often preoccupied with the number of idea sketches they generate rather than considering their quality (see Table 19).

Scale 1. Never focus 2. Low focus 3. Slightly focus 4. Moderately focus 5. Focus mostly 6. Always focus

Function	Quantity		Quality	
	Mean	Standard Deviation	Mean	Standard Deviation
Planning	5.00	0.816	5.70	0.483
Design	5.00	1.061	5.71	0.470
Engineering	5.00	1.000	5.71	0.488

Table 18. Level of importance of idea quantity and quality when generating ideas

Function	Content	Frequency (%) Times Mentioned
Planning	• High-quality ideas contribute to making innovative new products that distinguish them from competitors.	100
	• The more ideas they produce, the more likely they are to find high-quality ideas.	50
	• It is also important to consider how to reuse unselected high-quality ideas.	30
Design	• High-quality ideas contribute to making innovative new products that distinguish them from competitors.	88
	• It is also important to consider how to reuse unselected high-quality ideas.	41
	• Designers are often preoccupied with the number of idea sketches they generate rather than considering their quality if their managers prefer a quantity-oriented style for generating ideas.	35
	• The more ideas they produce, the more likely they are to find high-quality ideas.	35
Engineering	• High-quality ideas contribute to making innovative new products that distinguish them from competitors.	86
	• The more ideas they produce, the more likely they are to find high-quality ideas.	43

Table 19. Qualitative study findings on the importance of qualitative or quantitative ideas

(3) Defining idea quality

The study focused on asking the sample interviewees three specific questions about defining idea quality:

1) How important are following factors to define the quality of ideas? 2) How effective are following factors to define the quality of ideas? and 3) How often do teams use following 8 factors to define the quality of ideas (i.e., novelty, feasibility, business objectives, fit with capability, market potential, consumer benefit, gut feeling, other)?

(3-1) Importance: How important are the following factors in defining the quality of ideas? (Interview Q: A.5)

All three sample-groups in the main study commonly regarded the consumer benefit factor as one of the crucial elements in defining idea quality (see Table 20, 21 and Appendix 2-1). Specifically, the planning team emphasised the importance of the consumer benefit, and the design team put a priority on novelty. It is also noteworthy that the engineering team showed higher market trend points than the planning team that is typically known to be sensitive to market conditions (see Table 20). Of the planning team interviewees in the main study, 70% indicated that consumer feedback and satisfaction are important when generating ideas, since they largely affect the success of products in the current market. Also, 59% of designers in the main study concurred that emotional attraction or novelty is important for defining idea quality, as there are many competitors with similar functions in the market (see Table 21).

In addition, the design team rated the gut feeling factor much more highly than the other teams, and there was a significant gap between the engineering and design teams in terms of feasibility (see Table 20 and Appendix 2-2).

Of designers in the main study, 18% felt that people thinking too seriously about feasibility might reduce the level of idea novelty. However, 57% of the engineering team in the main study argued that ideas lacking feasibility are pointless (see Table 21).

Scale
1. Never important 2. Low importance 3. Slightly Important 4. Moderately important 5. Fairly important 6. Always important

Function		Novelty	Feasibility	Business Objective	Fit with Capability	Market Potential	Consumer Benefit	Gut Feeling	Other
Planning	Mean	4.10	4.50	4.80	3.90	4.30	5.60	3.80	—
	Standard Deviation	1.370	1.080	1.398	0.738	1.418	0.699	1.229	—
Design	Mean	5.41	3.76	4.35	3.53	4.71	4.94	5.06	—
	Standard Deviation	0.795	1.251	1.115	1.231	0.985	0.899	1.088	—
Engineering	Mean	4.00	5.43	4.86	4.71	5.43	5.14	3.86	—
	Standard Deviation	1.291	0.976	1.215	0.951	0.787	1.215	1.574	—

Table 20. Defining importance of idea quality

Function	Content	Frequency (%) Times Mentioned
Planning	• Success of new products within recent market environment is largely affected by consumer feedback and satisfaction	70
	• Ideas aligned with company's business objectives can bring less confusion, since the ideas are developed within an environment in which companies have already prepared expected budgets or resources	40
	• Inappropriate ideas for business objectives cannot be selected by decision makers	30
	• No matter how great the idea is, it should be feasible	10
Design	• Emotional attraction or novelty is related to consumers' purchasing desires, as many competitors have similar functions in a recent market	59
	• Success of new products within a recent market environment is largely affected by consumers' evaluations	47
	• Identifying potential value in the market means being potential leaders of the market	29
	• Inappropriate ideas for business objectives cannot be selected by decision makers	18
	• If people think too seriously about whether the idea is practical or not, it is not easy to create various novel ideas	18
Engineering	• No matter how great the idea is, it should be feasible	57
	• Success of new products within a recent market environment is largely affected by consumers' evaluations	57
	• Inappropriate ideas for business objectives cannot be selected by decision makers	29
	• Identifying potential value in the market means being potential leaders of the market	29

Table 21. Qualitative study findings on the defining Importance of idea quality

(3-2) Effectiveness: How effective are the following factors in defining the quality of ideas? (Interview Q: A.5)

The result of the questions about effectiveness revealed a similarity to that of importance. However, three sample teams' answers showed in common that the effectiveness of business objectives is significantly less than that of their importance (see Appendixes 4). In the main study, 65% of designers and 57% of engineers indicated that they feel less uncertain when they use factors related to their work while defining the quality of their ideas, which was the main reason why they preferred novelty or feasibility factors (see Table 23). Also, this study showed that design team significantly regards novelty and gut feeling as effective factors when generating ideas, compared with the other two teams (see Table 22 and Appendix 3-2). According to 41% of main qualitative interview participants from the design team, emotional attraction or novelty is related to consumers' purchasing desires in recent markets (see Table 23).

Scale
1. Never effective 2. Low effectiveness 3. Slightly effective 4. Moderately effective 5. Fairly effective 6. Always effective

Function		Novelty	Feasibility	Business Objectives	Fit with Capability	Market Potential	Consumer Benefit	Gut Feeling	Other
Planning	Mean	4.10	4.20	3.70	4.30	3.60	4.90	3.90	—
	Standard Deviation	1.197	1.135	1.160	1.252	1.174	1.197	1.449	—
Design	Mean	5.35	4.41	3.12	3.47	4.12	4.88	5.29	—
	Standard Deviation	0.931	1.004	0.928	1.007	1.364	1.111	0.772	—
Engineering	Mean	4.86	4.86	3.57	4.14	4.71	4.57	3.86	—
	Standard Deviation	0.900	1.864	1.272	1.676	1.113	1.134	1.215	—

Table 22. Defining effectiveness of idea quality

Function	Content	Frequency (%) Times Mentioned
Planning	• Success of new products within recent market environment is largely affected by consumer feedback and satisfaction	80
	• No matter how great the idea is, it should be feasible	50
	• Novelty is related to consumers' purchasing desires, as similar functional products are competing in recent market	20
Design	• Considering factors familiar with designers' main role enables reduction of uncertainty when defining idea quality	65
	• Success of new products within recent market environment is largely affected by consumer feedback and satisfaction	47
	• Emotional attraction or novelty is related to consumers' purchasing desires as there are many competitors that have similar functions in a recent market	41
	• No matter how great the idea is, it should be feasible	18
Engineering	• No matter how great the idea is, it should be feasible	86
	• Considering factors familiar with engineers' main role enables reduction of uncertainty when defining idea quality	57
	• Novelty is related to consumers' purchasing desires, as many competitors have similar functions in a recent market	29

Table 23. Qualitative study findings on the defining effectiveness of idea quality

(3-3) Frequency: How often do teams use following 8 factors to define the quality of ideas? (Interview Q: A.5)

Of total interviewees in the main study, 97% agreed that the alignment between the ideas and business objectives is mainly considered when defining idea quality in projects, since usually ideas are selected by planning division or project directors, who prefer using logical evidence or the safest methods (see Tables 24 and 25 and Appendix 5-1).

During this interview, 94% of total interviewees in the main study displayed a common view of the different characteristics of perspectives for defining idea quality between the three functional teams (planning: 90%, design: 94%, engineering: 100%) (see Table 25). According to them, planning teams appear to focus on rational and logical insights when generating ideas or defining idea quality, whereas the design teams seem to work with emotional and intuitional inspiration, and the engineering team considers feasibility and verification as a key driver. Furthermore, the 94% of total interviewees revealed that their companies need to establish more practical methods to reduce gaps between the different perspectives to eliminate conflicts or arguments between different teams.

Regarding this discussion, 54% of practice-based teams (design: 59%, engineering: 43%) mentioned that they often face difficulties agreeing to the ideas selected by the planning team due to differing views on identifying qualities (see Table 25).

Scale
1. Never use 2. Low use 3. Slightly use 4. Moderately use 5. Use fairly often 6. Always use

Function		Novelty	Feasibility	Business Objective	Fit with Capability	Market Potential	Consumer Benefit	Gut Feeling	Other
Planning	Mean	3.80	4.40	5.50	4.30	4.40	5.30	3.10	-
	Standard Deviation	1.135	1.265	0.707	1.252	1.430	0.949	0.738	-
Design	Mean	4.59	4.65	4.76	4.00	3.88	4.71	3.71	-
	Standard Deviation	1.064	0.931	1.393	1.000	1.166	1.047	1.312	-
Engineering	Mean	3.14	5.43	5.71	5.43	4.43	4.14	3.29	-
	Standard Deviation	0.900	0.787	0.756	0.787	1.397	1.069	0.756	-

Table 24. Overall of factors frequently used when defining idea quality

Function	Content	Frequency (%) Times Mentioned
Planning	• Inappropriate ideas for business objectives cannot be selected by project directors who prefer the safest way	90
	• Different functional teams have different characteristics of perspectives for defining idea quality	90
	• Success of new products within recent market environment is largely affected by consumer evaluation	70
Design	• Different functional teams have different characteristics of perspectives for defining idea quality	94
	• Usually idea quality is defined by the planning division or directors, who prefer using logical evidence	59

	• Difficulties agreeing with the selected ideas due to the differing idea quality preferences of planning team	59
	• Inappropriate ideas for business objectives cannot be selected by decision makers who prefer the safest way	47
	• Novelty is related to consumers' purchasing desires, as similar functional products are competing in recent market	29
	• Success of new products within recent market environment is largely affected by consumer evaluation	24
Engineering	• Different functional teams have different characteristics of perspectives for defining idea quality	100
	• Inappropriate ideas for business objectives cannot be selected by decision makers	71
	• No matter how great the idea is, it should be feasible while satisfying practically the requirements of legal, budget, time, and infrastructure	71
	• Usually idea quality is defined by planning division or directors, who prefer using logical evidence	43
	• Difficulties agreeing with the selected ideas due to different idea quality preference from planning team	43

Table 25. Qualitative study findings on the factors frequently used when defining idea quality

Key Findings

From the main study interviews, this study identified the following key insights related to MNEs idea generation processes:

- Team's role and leadership style of a manager have a direct impact on the performance (positive and negative) of the idea generation activities
- A top-down structured approach appears to create mistrust between the planning and the design and engineering teams
- Diverse perspectives between the different teams on defining idea quality can contribute to disagreements and mistrust between the functions

4.2.2. NPD Initiation and People Involvement

The aim of this stage within the study was to examine the issues related to NPD initiation and the people involved in the idea generation and development phase. The purpose of this phase was to: (1) explore the main reasons for initiating the new projects and (2) investigate the nature of each team's involvement in idea generation activities of NPD in order to identify meaningful difference between three sample groups of the main study.

(1) Reason for the initiation of new projects (Interview Q: B.1)

The findings indicated that three sample groups in the main study commonly stated market trends as one of the important reasons for embarking on new NPD projects (see Table 26). In addition, both planning and design teams stated that consumer needs and new social behaviour are important drivers for starting NPD (see Table 26 and Appendix 6). From the main study, 70% of planning team respondents considered consumer needs data when starting new projects, as accurate consumer feedback can provide a clearer direction for creating future products. Also in the main study, 82% of design team interviewees thought that new social culture and behaviour — trends, behaviour, and cultures newly emerging in recent society — are significant factors for starting NPD, as consumer behaviour can provide clues for companies to predict future market trends. Aligning with the views of 50% of the planning team participants, 71% of the engineers considered understanding market trends as a fundamental activity when planning new projects (see Table 27).

Scale (reflecting level of consideration)
1. Never 2. Low 3. Slightly 4. Moderately 5. Fairly often 6. Always.

Functions		Market Trends	Design Trends	Existing Problem	Consumer Needs	Competitive Products	New Technology Opportunities	New Social Culture and Behavior	Financial Effect	Environmental Effect	Legal Issue	Other
Planning	Mean	5.10	4.30	3.80	5.30	4.90	4.40	4.90	2.50	1.80	2.00	1.70
	Standard Deviation	0.994	0.949	1.229	0.823	0.994	0.966	0.738	0.972	0.789	0.943	1.64
Design	Mean	5.18	4.59	3.59	5.29	4.94	3.82	5.35	2.06	1.82	2.00	1.76
	Standard Deviation	0.728	1.004	1.064	0.920	1.088	1.286	0.862	1.298	1.286	1.414	1.44
Engineering	Mean	5.71	4.57	4.43	4.57	4.43	4.29	4.43	3.86	3.43	3.86	2.00
	Standard Deviation	0.488	0.787	1.618	1.397	1.134	1.254	1.272	1.069	1.902	1.952	1.73

Table 26. Reasons for the initiation of new projects

Function	Content	Frequency (%) Times Mentioned
Planning	• Consumer feedback gives clear direction for creating future products	70
	• Market trends are always basis of starting NPD	50
	• Consumer behaviour enables prediction of future market trends	30
	• No special reason; company's NPD schedule is already set	20

Design	• Consumer behaviour enables prediction of future market trends	82
	• Consumer feedback gives clear direction for creating future products	47
	• Usually embarking on NPD is a main role of planning team, rather than practice-based teams	35
	• No, special reason; company's NPD schedule is already set	24
Engineering	• Market trends are always basis of starting NPD	71
	• Identifying legal issues and estimating cost impacts on actual practice are roles of engineers	43
	• No special reason; company's NPD schedule is already set	29
	• Usually embarking on NPD is a main role of planning team, rather than practice-based teams	29
	• Existing issues can contribute to thinking of new ideas	14

Table 27. Qualitative study findings on the reasons for the initiate new projects

(2) People's involvement in idea generation and development stages

This phase investigated two specific questions: 1) which teams are typically most important in the idea generation and development stages? and 2) which teams are typically most effective within these stages?

(2-1) Importance: Which teams are typically most important in the idea generation and development stages? (Interview Q: B.2)

The outcomes of the importance of people's involvement revealed significant differences between three functional teams in the main study (see Table 28 and Appendix 7-1). While the planning team recognised themselves as a large influential team for generating ideas, as compared to the other two teams, the design team did not agree about the planning team's importance in the idea generation activity.

On the other hand, the design and engineering teams believed their involvement to be important when generating ideas, whilst the planning team failed to concur on the importance of the engineering team (see Table 28 and Appendix 7-2). Of the planning team's participants in the main study, 70% answered that their role is important for generating ideas, since one of their main roles is to analyse and define consumer needs. However, 59% of the design and 71% of the engineering teams emphasised the importance of the design team's involvement in idea generation stages. They suggested this because new products often need to attract both new and existing consumers via developing a strong emotional approach. They felt this aspect to be important because many products with similar functions are often available in the market (see Table 29).

In addition, planning and design teams indicated the crucial importance of the involvement of multidisciplinary teams in the idea generation phase. According to 60% of the planning and 53% of the design teams, more unique ideas are created in the idea generation stage when teams have a more varied range of expertise and experience (see Table 29).

Scale (level of importance of team's involvement)
1. Never 2. Low 3. Slightly 4. Moderately 5. Fairly 6. Always

Function		**Importance of Planning**	**Importance of Design**	**Importance of Engineering**	**Importance of Other**
Planning	Mean	5.90	5.00	4.10	6.00
	Standard Deviation	0.316	0.816	0.568	0.000
Design	Mean	4.82	5.59	4.94	5.47
	Standard Deviation	0.951	0.618	1.088	0.874
Engineering	Mean	5.00	5.57	5.14	4.43
	Standard Deviation	0.816	0.535	0.690	1.397

Table 28. Importance of teams' involvement in the idea generation stage

Function	Content	Frequency (%) Times Mentioned
Planning	• Analysis of consumer needs is a key activity of planning team	70
	• The more people with various expertise are involved, the more unique ideas they create	60
	• Planning teams are good at synthesising various information logically	30
	• All teams are important for generating new ideas, as the ideas need integrated sources	20
Design	• Applying emotional codes to ideas is important, since there are many similar functional products in the same market	59
	• The more people with various expertise are involved, the more unique ideas they create	53
	• Design and engineering teams may create more practically unique ideas than the planning team	29
	• All teams are important for generating new ideas, as the ideas need integrated sources	24
Engineering	• Applying emotional codes to ideas is important, since there are many similar functional products in the same market	71
	• For contributing to new ideas, developing one's own expertise within one's group of experts is a priority	43
	• Planning team is important in idea generation as a leader of the stage	14
	• Design and engineering teams may create more practically unique ideas than planning teams	14

Table 29. Qualitative study findings on the importance of teams' involvement in the idea generation stage

(2-2) Effectiveness: Which teams are typically most effective within these stages? (Interview Q: B.2)

The findings on the effectiveness of people's involvement were similar to those for importance; however, the gap between three sample groups was more significant (see Table 30 and Appendix 8-2).

The planning team stated that they are more effective in generating ideas than the design and engineering teams, while those teams believed that practice-based teams can suggest more efficient ways to create new ideas than the planning team. Eighty percent of the main interview participants from the planning team saw themselves as being highly effective. They based this view on their perceived knowledge of setting clearer goals for generating ideas, due to their function being to lead activity within the idea generation stage. Also, 60% of the planning team in the main study believed that rational and logical analysis is important for building the main concept, and the planning team is well trained in that activity (see Table 31). However, the answers of the design and engineering teams revealed their mistrust of the planning team's rational and logical analysis: 41% of the design and 29% of the engineering respondents indicated that they often feel the outcomes analysed by the planning team are too general and abstract to be used for generating innovative ideas (see Table 31). Of the main study interviewees, 65% of the design team and 43% of the engineering team continued to agree that the design team's unique perspectives on emotional factors when generating ideas can help make innovative products that are distinct from those of competitors in the current market. In addition, 53% of the designers and 57% of the engineers believed that potential problems relevant to developing actual products can be removed earlier if practice-based teams are actively involved in the idea generation stage (see Table 31).

Scale (Effectiveness of Involvement)

1. Never 2. Low 3. Slightly 4. Moderately 5. Fairly 6. Always

Function		Effectiveness of Planning	Effectiveness of Design	Effectiveness of Engineering	Effectiveness of Other
Planning	Mean	5.70	4.50	3.30	4.00
	Standard Deviation	0.675	0.850	0.823	0.667
Design	Mean	3.82	5.53	4.82	3.65
	Standard Deviation	0.883	0.717	1.131	0.931
Engineeri ng	Mean	4.29	5.71	5.43	3.71
	Standard Deviation	1.254	0.756	0.787	0.951

Table 30. Effectiveness of teams' involvement in the idea generation stage

Function	Contents	Frequency(%) ;Times Mentioned
Planning	• Planning team leads the development of the main NPD concept	80
	• Rational and logical analysis is important for building the main concept, and planning team perceives themselves to be well trained in that activity	60
	• There are practical limitations to having all functions be involved in the idea generation stages in MNEs, due to the size of the groups	40
	• The main purpose of a multidisciplinary meeting is usually for reporting recent issues of each team to the director, not for generating new ideas together	30
	• Following up the result from the multidisciplinary teams is not easy, since the teams are usually temporarily organised	20
Design	• Designer's emotional and unique approaches in generating ideas are competitive in the recent market	65
	• Potential problems relevant to developing actual products can be removed earlier if practice-based teams are involved in the idea generation stage actively	53
	• The planning team's results are often too general to be used to drive idea generation	41
	• The main purpose of multidisciplinary meetings is usually for reporting recent issues of each team to the director, not for generating new ideas together	18
Engineering	• Potential problems relevant to developing actual products can be removed earlier if practice-based teams are involved in the idea generation stage actively	57
	• Designer's emotional and unique approach in generating ideas are competitive in the recent market	43
	• Planning teams are good at developing rational and logical analysis, but the results are often too general and/or abstract for generating innovative ideas	29
	• The main purpose of multidisciplinary meetings is usually for reporting recent issues of each team to the director, not for generating new ideas together	14

Table 31. Qualitative study findings on the effectiveness of teams' involvement in the idea generation stage

(3) Frequency of functions typically involved in the idea generation and development stages (Interview Q: B.3)

The purpose of this study is to identify the actual level of involvement of each functional team. This study identified that the design and engineering teams are less involved in the focus and direction stages in the early part of NPD compared to the planning teams, and it implies that the design and engineering teams are not actively involved in the main idea generation activities of NPD.

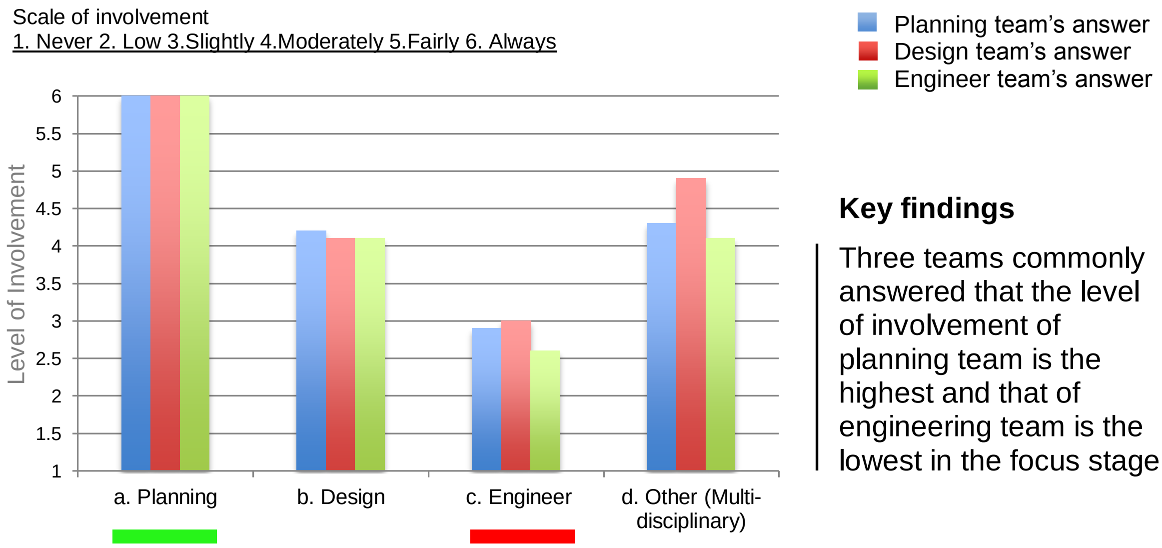
Namely, this study confirmed the top-down structured system of NPD in recent MNEs; the planning team leads idea generation activities to establish the NPD concept, and the design and engineering teams take over the concept from the planning team for actualising the ideas and creating real products.

Firstly, in the focus and direction stages, the level of planning team involvement is much higher than that of the other teams.

Secondly, the design team and engineering teams are highly involved in the development stage compared to the planning team.

Thirdly, the engineering team showed the lowest level of involvement in the primary idea generation activities, the focus and direction stages.

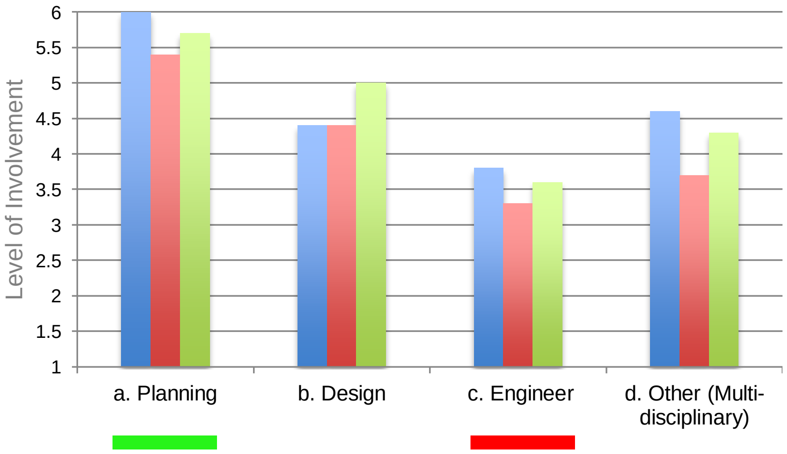
Lastly, multidisciplinary teams are involved more in the focus and direction stages compared with the development stage, but they do not lead any stage (see Chart 1, 2, and 3).



Key findings

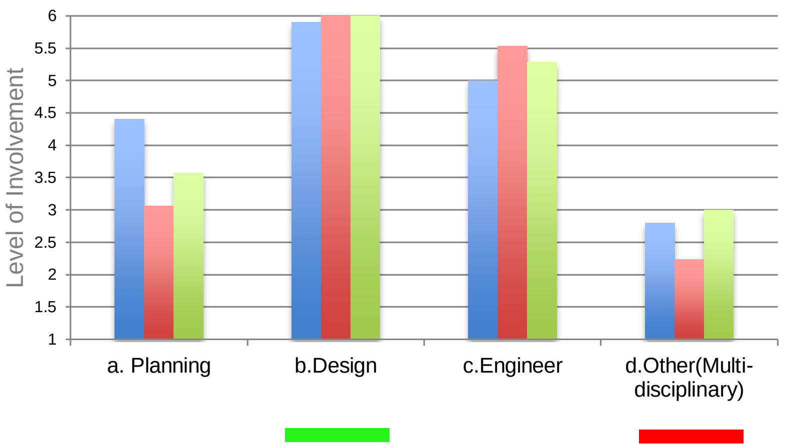
Three teams commonly answered that the level of involvement of planning team is the highest and that of engineering team is the lowest in the focus stage

Chart 1. Frequency of team involvement in the focus stage



Three teams commonly answered that the level of involvement of planning team is the highest in the direction stage, and that of design team in the direction stage is slightly higher than the focus stage

Chart 2. Frequency of team involvement in the direction stage



Three teams commonly answered that the levels of involvement of design and engineering teams are much higher than that of planning team in the development stage

Chart 3. Frequency of team involvement in the development stage

Key Activities

The three sample teams in the main study described their activities in each phase of an early stage of NPD, and the key activities of each team were found to be as follows:

1) Focus stage

	Planning	Design	Engineering
Key Activities	• Defining market opportunity, consumer needs, and social trends • Collecting data and delivering the data and information to other functions • Dividing the market into specific segments • Allocating human resources and budget and planning NPD time schedule • Organising cross-functional meetings for making initial plan of projects • Reporting the results of core activities of the focus phase such as market research and cross-functional meetings to product directors • Adjusting and developing overall plan	• Searching market, design trends, and new social needs data • Receiving a variety of data from internal research teams • Participating in cross-functional meetings for presenting emerging opportunities or issues from design field in recent market	• Searching for data on new technology, existing problems, and competitive products • Receiving a variety of data from internal research teams • Rarely involved in defining market opportunity with regard to patent (e.g., when the engineering team acquires patent) • Participating in cross-functional meetings for presenting emerging opportunities or issues from engineering field in recent market

Table 32. Key activities of planning, design, and engineering teams at focus stage

As the leader in the focus stage, the planning team performs a variety of activities to coordinate the overall plan. Typically, its main activity is collecting and analysing various market information, in order to comprehend emerging issues and trends and to identify new opportunities. They also divide the market into specific segments, and organise cross-functional meetings to make initial plans for projects. The design and engineering teams appear to be less involved in focus stages compared to the planning team. They seem to rarely identify market opportunity related to their fields; their main roles appear to center on receiving information from the research division every quarter. Also, the design and engineering teams regularly participate in cross-functional meetings arranged by the planning team to present emerging opportunities or issues in recent markets from the design or engineering field.

2) Direction stage

	Planning	Design	Engineering
Key Activities	• Establishing characteristics of the target consumer • Investigating customer needs (e.g., interview, shadowing, personas, survey) • Extracting target customer needs for applying it to product concept • Analysing issues discovered from research findings • Generating multiple product concepts • Reporting analysed results to programme directors • Selecting product concept (decision-makers: directors) • Implementing initial concept clinics: customer surveys • Comparing the results of surveys with competitive products • Adjusting overall plan of product • Setting detailed product concept • Being ready to hand in final results to practice-based division in a timely fashion	• Rarely involved in customer investigation programs with planning team • Rarely extracting target customer needs with planning team • Investigating user experience design or style based on target needs • Building initial design concept • Supporting planning team's initial concept clinics • Adjusting initial design concept and contents	• Investigating technology / mechanical design's initial specification based on target needs • Building initial engineering concept • Supporting planning team's initial concept clinics • Adjusting initial technology / mechanical concept and specification

Table 33. Key activities of planning, design, and engineering teams at direction stage

According to 97% of the total main interview respondents, performing consumer research and building the NPD concept are the main roles of the planning team in the direction stage. Specifically, 80% of the planning team in the main study described that they often cooperate with external research expert groups when attempting to discover consumer needs.

Typically, they use consumer interviews, surveys, shadowing and personas activities. Forty percent of planning team respondents also explained that people from other teams (especially the design team) are occasionally involved in the consumer research events. Planning teams typically analyse the consumer research data and identify the insights therein in order to set the NPD concept. Once the concept is set, the results are sent to other teams in the last part of the direction stage. The main role of the design and engineering teams in the direction stage seem to be to discover the specific content that targets consumer needs in relation to their fields in order to build the initial product design or engineering concept.

3) Development stage

	Planning	Design	Engineering
Key Activities	• Following up on the project's progress • Implementing product clinics regularly through customer surveys until a final mock-up is built • Reporting to programme directors on emerging issues in developing products • Adjusting the budget plan with engineering team • Developing a specific marketing plan	• Collecting data and analysing it for developing actual products • Setting final design concept • Creating idea sketch • Creating mock-up • Revising the product's specifications and mock-up based on the results of the product clinics • Cooperating with engineering teams whenever design contents and concept are changed • Cooperation with suppliers for quality checking the product	• Collecting data and analysing it for developing actual products • Setting final assembly scheme and engineering concept • Creating mock-up • Revising product's specifications and mock-up based on the results of the product clinics • Cooperation with design teams to check feasibility of the design contents • Cooperation with suppliers for developing moulds and quality checking the product • Examination of the financial, legal, and environmental issues

Table 34. Key activities of planning, design, and engineering teams at development stage

The level of planning team's involvement versus that of the design and engineering teams is flipped in the development stage, which is led by the latter.

Interestingly, 88% of the main study interviewees of design and 71% from engineering team stated that they frequently do not use the materials offered by research division (including planning team). The design and engineering teams collect their own data and get insights from their own perspectives in order to develop ideas in line with their practical works.

It appears that the issue may not lie with the data itself from the planning team but be more related to the analysis and insights derived, as 41% of interviewees from design team in the main study indicated that they often ask the planning team for raw consumer data, since they fail to agree with the planning team's analysis of these results. In this stage, close cooperation between the design and engineering teams is undertaken; the engineers check the feasibility of the designers' ideas. According to 43% of the main interview participants on the engineering team, while mock-up products are being built, they generally check on the financial, legal, and environmental issues that can have an impact on practical work. The planning team mainly monitors the progress of developing products and reports emergent issues to the directors.

It also emerged that the teams were aware of the issues and potential solutions, with 74% of interviewees in the main study agreeing that increasing the level of involvement of the practice-based teams in the idea generation stage would help enrich knowledge integration (planning: 80%, design: 82%, engineering: 43%). However, they also expressed doubts about how this might be achieved in practice, due to organisational size: They specifically pinpointed the potential difficulties of getting proper numbers of experts involved in the early stage of NPD.

Key Findings

This phase established the following key issues related to NPD initiation and employee involvement in idea generation:

- Blended factors mainly related to consumer behaviour and needs, including emotional attraction, are key determinants of success or failure in developing new products in current markets
- A lack of communication and feedback exchange among diverse teams expands the gap between their perspectives on the information discovered, which leads to mistrust between the teams
- Mistrust reduces the overall contribution of the research team's data and results to the development of new products

- The highest level of mistrust between diverse expert teams can specifically emerge from the different perspectives on consumer data, since consumer feedback appears to be a core element when building a product concept in current MNEs' NPD processes (e.g. implementing multiple consumer clinics across ES NPD to get consumer feedback)

4.2.3. Uncertainty in Idea Generation

This section aims to identify issues and opportunities related to the areas of uncertainty that exist between different functional teams in the current NPD practice of MNEs. Specifically, it explores reasons for the uncertainty typically experienced between three teams during idea generation and development activities. By examining why they feel this way, it attempts to establish how the uncertainty might be reduced.

(1) Level of Uncertainty (Interview Q: C.1)

The findings linked to understanding the levels of uncertainty experienced revealed a notable difference between the planning team and the design and engineering teams: the planning team indicated significantly high levels of uncertainty in the direction stage, while other two teams showed a large amount of uncertainty in the development stage (see Table 35 and Appendix 9). Of the total interviewees in the main study, 68% mentioned that they often feel a high level of uncertainty when they are deeply involved in NPD as a main team of the stage (planning: 50%, design: 71%, engineering: 86%) (see Table 36).

Scale (frequency of facing uncertainty)
1. Never 2. Rarely 3. Sometimes 4. Moderately 5. Frequently 6. Always

Function		Focus	Direction	Development
Planning	Mean	3.80	5.80	3.70
	Standard Deviation	1.033	0.422	0.675
Design	Mean	3.29	4.76	5.00
	Standard Deviation	1.105	1.251	0.866
Engineering	Mean	2.57	4.43	5.29
	Standard Deviation	1.134	1.272	0.951

Table 35. Average of levels of uncertainty

Function	Content	Frequency (%) Times Mentioned
Planning	• Building an NPD concept linked deeply to the results of the NPD is established at the direction stage, so much anxiety exists about failure at the direction stage	70
	• When the level of planning team involvement is high in NPD practices, feel high level of uncertainty because of the responsibility	50
Design	• When the level of design team involvement is high in NPD practices, feel high level of uncertainty because of the responsibility	71
	• Building an NPD concept linked deeply to the results of the NPD is established at the direction stage, so much anxiety exists about failure at the direction stage	29
Engineering	• When the level of engineering team involvement is high in NPD practices, feel high level of uncertainty because of the responsibility	86
	• Building an NPD concept linked deeply to the results of the NPD is established at the direction stage, so much anxiety exists about failure at the direction stage	14

Table 36. Qualitative study findings on the level of uncertainty

(2) Reason for Uncertainty (Interview Q: C.2)

The findings showed that each functional team in the main study often considers consumer benefit when generating ideas (see Table 37 and Appendix 10-1). The results also revealed that all three sample groups usually face high levels of uncertainty linked to factors related to their main roles. For example, business objectives significantly influence the planning team's level of uncertainty much more than that of the other teams, because setting the NPD direction aligned to business goals is seen as one of their main roles (60% of planning team's respondents). In contrast, 47% of design team respondents indicated that their uncertainty is significantly affected by novelty, as they are usually asked to create distinctive ideas, including ones involving emotional attraction or novelty (see Table 38). An emergent issue is that the design teams are much less influenced by the capability factor than the other two teams (see Table 37 and Appendix 10-2). 71% of engineering interviewees stated that they feel a high level of uncertainty when product or design concepts seems difficult to realise (see Table 38).

Scale (level of uncertainty)
1. Never 2. Low 3. Slightly 4. Moderately 5. Fairly 6. Always

Functions		Novelty	Feasibility	Business Objectives	Fit with Capability	Market Potential	Consumer Benefit	Gut Feeling	Other
Planning	Mean	4.50	4.80	5.70	4.20	4.70	5.70	3.00	-
	Standard Deviation	0.707	0.632	0.675	0.789	1.059	0.483	1.247	-

Design	Mean	5.71	4.35	3.06	3.12	4.00	5.12	5.59	-
	Standard Deviation	0.588	0.862	1.029	0.857	1.173	0.928	0.795	-
Engineering	Mean	4.29	4.86	3.29	4.29	4.14	4.71	3.57	-
	Standard Deviation	1.113	0.900	1.113	0.951	1.345	0.756	1.397	-

Table 37. Average of reasons for uncertainty

Function	Content	Frequency (%) Times Mentioned
Planning	• One of planning team's main roles is setting the NPD direction aligned to business goals	60
	• Success of new products in recent market environment is largely affected by consumer needs and benefits	40
Design	• Companies usually ask design team to create distinctive ideas that include emotional attraction or novelty	47
	• Success of new products in recent market environment is largely affected by consumer needs and benefits	47
	• Distinctive design is often inspired by designers' intuition, linked to their own insight, but it is difficult to convince other teams of these ideas without logic or evidence	41
Engineering	• When engineering teams receive ideas with low feasibility for developing, it leads to uncertainty and being anxious	71
	• Engineering team often considers consumer benefit related to new technologies	57

Table 38. Qualitative study findings on the reasons for uncertainty

(3) Reducing Uncertainty through Communication

This phase implemented two sets of questions about the correlation between the level of communication among different teams (i.e., planning, design, and engineering team or others) and the level of uncertainty when generating ideas: (1) With which team is communication important to reduce uncertainty? (2) With which team is communication effective in reducing uncertainty?

(3-1) Importance: With which team is communication important in reducing uncertainty? (Interview Q: C.3)

This phase found two general tendencies in three sample groups. First, all three teams regard the importance of communication with colleagues in their own team as significant for reducing uncertainty (see Table 39 and Appendix 11-1). According to 65% of the total interviewees in the main study, this is because colleagues who understand their role and perspectives can give practical and valuable advice when generating ideas in the NPD process (planning: 60%, design: 76%, engineeriing: 43%) (see Table 40).

Second, 47% of total interviewees in the main study illustrated that obtaining various types of knowledge by communication with the other expert groups is important to reduce uncertainty when generating ideas (planning: 60%, design: 41%, engineering: 43%) (see Table 40).

However, design and engineering teams appear to trust practice-based divisions more than planning teams when generating ideas, since the design and engineering teams seem to understand and respect each other's roles and language in the NPD process, compared to those of the planning team (see Tables 39 and 40, and Appendix 11-2).

Scale (importance)
1. Never 2. Low 3. Slightly 4. Moderately 5. Fairly 6. Always

Function		Communication with Planning	Communication with Design	Communication with Engineering	Communication with Other
Planning	Mean	5.60	5.00	4.60	5.40
	Standard Deviation	0.699	0.816	0.516	1.265
Design	Mean	5.18	5.88	5.35	4.94
	Standard Deviation	1.131	0.332	0.862	1.197
Engineering	Mean	4.86	5.71	5.71	4.86
	Standard Deviation	0.900	0.488	0.488	1.464

Table 39. Importance of communication between teams for reducing uncertainty levels

Function	Content	Frequency (%) Times Mentioned
Planning	• Obtaining various types of knowledge from diverse expert groups is helpful to reduce uncertainty when generating ideas	60
	• Colleagues in the planning team can give valuable practical advice, since they understand its role and perspectives when generating ideas in the NPD process	60
Design	• Colleagues in the design team can give valuable practical advice, since they understand the design team's role and perspectives when generating ideas in NPD process	76
	• Obtaining various types of knowledge from diverse expert groups is helpful to reduce uncertainty when generating ideas	41
	• Communication with the engineering team is important to find out practical issues earlier	35
	• Communication with the planning team is important, as they know the clear purpose of the NPD	18
Engineering	• Obtaining various types of knowledge from diverse expert groups is helpful to reduce uncertainty when generating ideas	43

	• Colleagues in the engineering team can give valuable practical advice, since they understand the engineering team's role and perspectives when generating ideas in the NPD process	43
	• The role of the design team in developing NPD is important in recent markets, since they handle a variety of factors related to consumer behaviour and needs, including emotional attraction	14

Table 40. Qualitative study findings on the importance of communication between teams for reducing uncertainty

(3-2) Effectiveness: With which team is communication effective in reducing uncertainty? (Interview Q: C.3)

The mistrust between the planning team and the design and engineering teams clearly appeared in the findings in this question. The results on effectiveness illustrated the significant difference between the two types of groups (planning team versus design/engineering teams). The planning team believes that communication between the design and engineering teams is much less effective in reducing uncertainty than communicating with their own planning team, which appears to be contrary to the responses of the design and engineering teams (see Table 41 and Appendix 12-1 and 12-2).

Regarding this, 50% of the planning team and 53% of the design team in the main study illustrated that a lack of understanding of different roles and perspectives between the planning and design/engineering teams creates potential difficulties in the communication between them (see Table 42). Similar to the findings from the question about importance, 76% of total respondents in the main study stated that communication with colleagues who have similar expertise is more effective in reducing uncertainty, since they can offer beneficial opinions through a sufficient understanding of the team's role and perspectives when generating ideas (planning: 80%, design: 82%, engineering: 57%) (see Table 42).

Scale (communication: level of effectiveness)
1. Never 2. Low 3. Slightly 4. Moderately 5. Fairly 6. Always

Function		Communication with Planning	Communication with Design	Communication with Engineering	Communication with Other
Planning	Mean	5.80	4.80	3.60	4.10
	Standard Deviation	0.632	0.919	0.966	0.876
Design	Mean	4.00	5.94	4.88	3.47
	Standard Deviation	1.275	0.243	1.111	1.007
Engineering	Mean	3.71	5.57	5.57	3.57
	Standard Deviation	1.113	0.787	0.787	0.976

Table 41. Effectiveness of communication between teams for reducing uncertainty levels

Function	Content	Frequency (%) Times Mentioned
Planning	• Colleagues on planning team can give valuable practical advice, since they understand its role and perspectives when generating ideas in NPD process	80
	• Lack of understanding of different role and perspectives between the planning team and practice-based teams often brings arguments	50
	• Cross-functional meetings are inefficient, since participants from various teams usually focus on reporting emerging issues to director instead of generating new ideas together	20
	• Employees usually do not focus on the activities of a multidisciplinary team, since the team is usually established temporarily, and companies do not have an appropriate rewards system for its outcome	20
Design	• Colleagues on design team can give valuable practical advice, since they understand design team's role and perspectives when generating ideas in NPD process	82
	• Communication with planning team often brings difficulties, as they ask to show logical proof and do not understand design team's language	53
	• Communication with engineering team is effective to find out practical issues earlier	29
	• Employees usually do not focus on the activities of multidisciplinary team, since the team is usually established temporarily and companies do not have an appropriate rewards system for its outcome	18
Engineering	• Communication with the design team is effective to reduce uncertainty, since they address a variety of factors related to consumers and understand the role of practical works	71
	• Colleagues on engineering team can give valuable practical advice, since they understand engineering team's role and perspectives when generating ideas in NPD process	57
	• Cross-functional meetings are inefficient, since participants from various teams usually focus on reporting emerging issues to director instead of generating new ideas together	14

Table 42. Qualitative study findings on the effectiveness of communication between teams for reducing uncertainty

Key Findings

This study found the following key insights from the interview relating to uncertainty when generating and developing ideas:

- A team's role in NPD projects and its own perspectives on selecting and defining idea quality affects the levels of and reasons for uncertainty in the idea generation stage of NPD
- Understanding of other teams' different roles and perspectives in NPD can contribute to reducing mistrust and uncertainty in the idea generation stage

4.2.4. Data, Information and Insights (DII) that Stimulate Generating Ideas

This study explored the nature of used data and data collection / sharing process in relation to supporting idea generation activities. It was established for understanding how the data and process are utilised within ES NPD practices.
Specifically, this study examined: 1) data use process, 2) which DII three sample-teams (the planning, design and engineering teams) use for stimulating idea generation, 3) from where DII is collected, and 4) which formats of DII three sample-groups use. In addition, the study investigated the difference between the three sample-groups in use of internal research data.

(1) Data, Information, and Insights (DII) Use Process (Interview Q: D.1)
The purpose of this question was to identify the nature of the data and data use process used in the idea generation phase of NPD. Also, it discovers the differences between the planning, design, and engineering teams in this respect. In general, the three teams showed similar results: an informal and unstructured process is more often performed, and data are usually collected directly (e.g., web search engine).
However, two significantly dissimilar findings were also established. The engineering team's responses indicated a significantly low use of formalised ways of collecting data compared to the other teams. In addition, the planning team indicated that they used more indirect (expert-driven) approaches (e.g., indirect methods — data filtered by experts) for collecting data than the other teams (see Table 43 and Appendix 13).

Scale
1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Formal	Informal	Structured	Unstructured	Direct	Indirect
Planning	Mean	4.00	4.60	3.60	4.60	6.00	5.40
	Standard Deviation	1.05	0.84	0.97	0.84	0.00	0.84
Design	Mean	3.94	4.53	3.82	4.53	5.82	4.12
	Standard Deviation	0.97	1.01	0.88	1.07	0.39	1.22
Engineering	Mean	2.86	5.14	3.14	4.57	5.86	3.29
	Standard Deviation	0.69	0.69	1.35	0.79	0.38	1.11

Table 43. Overall nature of usage of data - process

(2) Nature of data use (contents): which DII three sample-teams use for stimulating idea generation

This section focused on investigating how data are used when generating ideas. It explored specifically the importance and effectiveness of 11 types of data (i.e., market trends, design trends, existing problem, consumer needs, competitive products, new technology opportunities, new social culture and behaviour, financial effect, environmental effect, legal issue, other).

(2-1) Importance: which DII are important for generating ideas? (Interview Q: D.2.1)

The findings indicated that three sample groups in the main study commonly regarded consumer-relevant data as important (e.g, consumer needs, new social behaviour) (see Table 44 and Appendix 14-1). For instance, 68% of the main study participants indicated that consumer behaviour data help them gain insights into future consumer needs, and consequently all three teams believed that these data help business to foresee future lifestyle trends (planning: 60%, design: 76%, engineering: 57%) (see Table 45). Interestingly, all three teams rated their own expertise as one of the most important factors for generating ideas: Product planning teams focused on consumer data, design teams centred on design trend data, and engineering team concentrated on new technology data (see Table 44).

The findings identified meaningful differences in the responses from the design and engineering teams. Design teams indicated a significantly high level of importance in the use of data unrelated to NPD subjects (see other data in Table 44 and Appendix 14-2); for example, 24% of designers responded that they often use data unrelated to the NPD theme directly when creating new ideas such as flowers or architecture (stimulus and creative catalyst type data). The level of importance of finance, environment, and legal data was more relevant to the engineering teams: 43% of them indicated that ideas cannot be adopted into actual projects if they do not meet regulations (see Table 44, 45, Appendix 14-2).

Scale
1.Never important 2.Low important 3.Slightly Important 4.moderately important 5.Fairly important 6. Always important

Functions		Market Trends	Design Trends	Existing Problem	Consumer Needs	Competitive Products	New Technology Opportunities	New Social Culture and Behaviour	Financial Effect	Environme-ntal Effect	Legal Issue	Other
Planning	Mean	4.90	4.20	4.70	5.50	4.40	4.70	5.80	2.10	1.50	1.80	1.40
	Standard Deviation	0.88	0.79	1.16	0.97	1.35	0.48	0.63	0.99	0.71	0.92	0.70
Design	Mean	5.18	5.29	4.18	5.29	4.00	4.65	5.53	2.00	2.06	1.65	5.06
	Standard Deviation	0.81	0.92	1.13	0.69	1.46	0.79	0.72	1.17	1.14	0.79	0.90
Engineering	Mean	4.57	4.57	5.00	5.00	4.86	5.43	5.00	4.71	3.71	4.86	1.14
	Standard Deviation	0.79	0.98	0.82	0.82	1.21	0.79	1.29	1.50	1.89	1.07	0.38

Table 44. Overall nature of usage of data- important data

Function	Contents	Frequency (%) Times Mentioned
Planning	• Consumer behaviour data gives a clue about what they need in the future	60
	• Reading trends is the basis of creating ideas	50
	• Finding opportunities from accurate consumer feedback is better than guessing opportunities based on recent trends	30
	• Excessive consideration of costs or regulations will be a stumbling block to generating new ideas	20
	• It is possible that the design trend has already been changed at the time of launching a new product	10
Design	• Consumer behaviour data gives a clue about what they need in the future	76
	• Reading trends is the basis of creating ideas	53
	• Consumer data is always a priority	29
	• Sometimes data unrelated to NPD themes, such as nature or architecture, stimulates creative new ideas	24
	• All data is important for generating new ideas	18
	• Excessive consideration of competing products may lead to limitation in creating new ideas	6
Engineering	• Recent consumer lifestyle usually follows the new technology	71
	• Reading trends is the basis of creating ideas	57
	• Consumer data is always a priority	57
	• All data is important for generating new ideas	43
	• No matter how good an idea is, it should meet the regulations	43
	• Unique solutions or ideas often come in comparison with competing products	14

Table 45. Qualitative study findings on the important data

(2-2) Effectiveness: Which DII are effective for idea generation? (Interview Q: D.2.1)

The findings linked to effective data content when generating ideas were similar to those for importance of data content: The design and engineering teams showed a striking contrast in their use of data unrelated to NPD themes, and in the use of environmental, financial, and legal data (see Table 46 and Appendix 15-2).

The planning team revealed a significantly high level of effectiveness in the use of market trend and consumer needs data, and design team respondents emphasised design trend data more strongly. The result of the engineering team's answers indicated that they usually consider substantial, concrete data (e.g., existing problems, competitive products) more than the other teams do (see Table 46 and Appendix 15-1). Regarding this, 59% of designers in the qualitative interview of the main study mentioned that the design trend data helped them to comprehend current design trends so that they could create advanced levels of ideas and avoid existing styles. In addition, 57% of interviewees from the engineering team in the main study responded that existing problem data enable them to prevent the same problems from arising in new projects (see Table 47).

Scale
1.Never effective 2.Low effective 3.Slightly effective 4.moderately effective 5.Fairly effective 6. Always effective

Functions		Market Trends	Design Trends	Existing Problem	Consumer Needs	Competitive Products	New Technology Opportunities	New Social Culture and Behaviour	Financial Effect	Environmental Effect	Legal Issue	Other
Planning	Mean	4.90	4.00	4.40	5.00	4.90	4.10	5.30	2.40	1.60	1.80	1.00
	Standard Deviation	0.57	0.82	0.97	0.94	0.99	1.29	0.95	1.17	0.52	0.79	0.00
Design	Mean	4.00	5.12	3.88	4.41	4.00	4.18	5.41	2.00	1.88	1.82	4.82
	Standard Deviation	0.50	0.99	1.17	1.00	1.12	0.81	0.94	1.32	1.11	1.01	1.01
Engineering	Mean	4.29	3.86	5.57	4.57	5.29	4.86	4.29	4.29	3.43	4.57	1.00
	Standard Deviation	1.25	1.07	0.53	1.13	0.76	1.07	1.11	1.25	1.13	1.40	0.00

Table 46. Overall nature of usage of data- effective data

Function	Contents	Frequency (%) Times Mentioned
Planning	• Consumer data always gives a clear direction for new ideas	70
	• Consumer behaviour data gives a clue about what they will need in the future	50
	• Reading trends is the basis of creating ideas	30
	• Unique solutions or ideas often come in comparison with competing products	30
Design	• Consumer behaviour data gives a clue about what they will need in the future	71

	• Comprehending design trends can contribute to designers thinking of ideas at an advanced level	59
	• Sometimes data irrelevant to NPD themes stimulates creative new ideas	24
	• New technology information influences new design ideas	12
Engineering	• Understanding an existing problem can help to avoid the same issues in new projects	57
	• Unique solutions or ideas often come in comparison with competing products	43
	• New technology information offers new future lifestyles	29
	• No matter how good an idea is, it should meet the regulations	29

Table 47. Qualitative study findings on the effective data

(2-3) Frequency: which DII do the three sample teams frequently use for idea generation? (Interview Q: D.2.2)

This question examines the actual use of data in the idea generation phase of NPD stage by stage (focus, direction, development). This investigation aims to identify the nature of the practical use of data between different types of functional divisions and the difference betweens them.

1) Focus Stage

Specifically, the overall result of the focus stage showed a significant difference between the planning team and the other teams. In the main study, the planning team usually used various data themes in the focus stage to comprehend overall key issues (e.g., market trends, consumer and social behaviour, existing problems), while the design and engineering teams preferred using specific themes practically related to their primary activities (see Table 48 and Appendix 16-1). The design team in the main study used design trends and new social behaviour data extensively, and the engineering team mainly used new technology data and the data contributing to a tangible solution, such as existing problems or data on competitive products. In this regard, 40% of planning team respondents in the main study stated that comprehending various content is necessary when starting idea generation process. Of the designer interviewees in the main study, 47% pointed out that consumer behaviour data can enable them to imagine what consumer needs will be in the future. Of the engineers in the main study, 57% mentioned that clarification of current issues and competitors contributes to a good NPD start (see Table 49). The results also indicated that the design team's use of other data is much higher than the other teams (see Table 48 and Appendix 16-2).

Scale
1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Market Trends	Design Trends	Existing Problem	Consumer Needs	Competitive Products	New Technology Opportunities	New Social Culture and Behaviour	Financial Effect	Environmental Effect	Legal Issue	Other
Planning	Mean	5.50	3.90	5.00	5.50	4.80	4.00	5.50	2.20	2.00	1.70	1.00
	Standard Deviation	0.71	0.57	0.82	0.71	1.40	0.94	0.53	0.63	0.47	0.95	0.00
Design	Mean	5.35	5.35	4.35	5.06	4.18	4.18	5.59	1.71	1.94	1.53	4.06
	Standard Deviation	0.70	0.86	1.46	0.83	1.42	1.01	0.71	0.77	0.90	0.62	1.09
Engineering	Mean	4.71	4.00	5.71	4.86	5.43	5.86	4.14	2.57	2.14	2.43	1.00
	Standard Deviation	0.95	1.53	0.49	0.90	1.13	0.38	0.69	0.98	0.90	1.13	0.00

Table 48. Overall nature of usage of data – data frequently used in the focus stage

Function	Contents	Frequency (%) Times Mentioned
Planning	• Comprehending multiple kinds of information is necessary for the first stage of the idea generation phase	40
	• Market trends give overall information for establishing the basis of NPD	40
	• Consumer data is always a priority	30
Design	• Consumer behaviour data gives a clue about what they will need in the future	47
	• Trends data gives a direction for establishing the basis of NPD	29
	• Comprehending multiple kinds of information is necessary for the first stage of the idea generation phase	24
	• Unrelated material can bring inspiration when starting new idea generation	24
	• Consumer data is always a priority	6
Engineering	• Clarification of current issues and competitors is a good starting point	57
	• Finding opportunities within expertise area would be effective in idea generation	43
	• Consumer data is always a priority	14

Table 49. Qualitative study findings on the data frequently used in the focus stage

2) Direction Stage

The results of the direction stage were similar to those of focus stage. In the main study, 80% of planning team interviewees responded that consumer data are used more significantly often in the direction stage in order to find target consumers' preferences (see Table 51 and Appendix 17-1), while compared to the other teams, the design team continued to indicate a higher level of use of the design trends data and data unlinked to NPD subject (see Table 50 and Appendix 17-2).

The outcomes of the direction stage revealed a significant gap between the engineering team and the other two teams: The engineering team's use of new technology data was much higher than that of the planning team, and its use of financial and legal issue data was much higher than that of the design team.

Scale
1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Market Trends	Design Trends	Existing Problem	Consumer Needs	Competitive Products	New Technology Opportunities	New Social Culture and Behaviour	Financial Effect	Environmental Effect	Legal Issue	Other
Planning	Mean	4.40	3.70	4.70	5.80	5.20	3.10	5.40	3.00	2.00	2.50	1.00
	Standard Deviation	1.07	1.06	0.82	0.42	0.63	0.57	0.84	1.25	0.67	1.08	0.00
Design	Mean	4.00	5.35	4.00	4.94	4.00	3.47	5.47	2.00	1.59	2.00	3.18
	Standard Deviation	0.87	0.79	0.79	1.03	1.41	0.80	0.94	1.06	0.62	1.06	1.19
Engineering	Mean	3.86	3.29	4.43	4.43	4.14	4.43	4.29	3.86	2.71	3.43	1.00
	Standard Deviation	1.35	1.11	1.13	1.27	1.07	0.98	1.25	1.35	1.25	1.40	0.00

Table 50. Overall nature of usage of data – data frequently used in the direction stage

Function	Contents	Frequency (%) Times Mentioned
Planning	• Consumer data is often used to find target consumers' preferences	80
	• Consumer behaviour data gives a clue about what they will need in the future	30
	• In the direction stage, a company's capacity for NPD is considered (finance or legal requirements)	10
Design	• Consumer behaviour data gives a clue about what they will need in the future	65
	• Comprehending design trends can contribute to designers thinking of ideas at an advanced level	53
	• Consumer data is often used to find target consumers' preferences	29
	• Excessive consideration of competing products in the direction stage may cause similarity with competitors	6
	• Unrelated material can bring inspiration when generating new ideas, especially for appearance development	6
Engineering	• Finding opportunities in expertise area is always preferred in idea generation processes	71
	• Consumer data is used to find target consumers' preferences	43
	• No matter how good an idea is, it should meet the budget and regulations	29

Table 51. Qualitative study findings on the data frequently used in the direction stage

3) Development Stage

In the development stage, the design and engineering teams showed an intensive use of data closely related to their practical activities or roles at that stage: The design team focused on design trends, new social behaviour, and data unrelated to NPD subjects. However, they showed less consideration of the data related to consumer needs, finance, environment, and legal issues. The engineering team in the main study used new technology, finance, environment, and legal issue data more than the other teams, but they used social behaviour data less frequently (see Table 52 and Appendix 18-1 and 18-2).

Predictably, 88% of the design team and 57% of the engineering teams answered that they normally use the data relevant to their expertise for developing detailed and practical NPD concepts.

Also, 59% of designer respondents in the main study indicated that they frequently use data unrelated to the NPD theme (e.g., architecture, food, etc.) to access unique, creative inspiration for styling new products in development (see Table 53).

Scale
1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Market Trends	Design Trends	Existing Problem	Consumer Needs	Competitive Products	New Technology Opportunities	New Social Culture and Behaviour	Financial Effect	Environmental Effect	Legal Issue	Other
Planning	Mean	3.60	5.00	3.80	5.10	4.80	3.90	5.40	2.50	1.70	1.90	1.00
	Standard Deviation	0.70	0.94	1.14	0.74	1.23	1.10	0.70	1.43	0.48	0.99	0.00
Design	Mean	3.47	5.88	3.65	3.94	4.29	3.65	5.06	1.35	1.53	1.76	5.18
	Standard Deviation	0.87	0.33	1.00	0.97	0.99	1.06	1.14	0.49	0.80	0.75	1.01
Engineering	Mean	3.43	3.71	3.71	4.57	4.43	4.71	3.71	4.71	3.29	4.86	1.00
	Standard Deviation	0.98	1.50	0.49	1.13	1.13	0.95	1.11	1.38	2.06	1.46	0.00

Table 52. Overall nature of usage of data – data frequently used in the development stage

Function	Contents	Frequency (%) Times Mentioned
Planning	• Consumer data is often used to find target consumers' preferences	40
	• Design trend data is useful for communication with the design team in the development stage	40
	• Consumer behaviour or new culture data is contributing to developing a detailed concept of NPD	20
	• Competitors' data is used to check the new product's merits and faults	20
Design	• Designers often refer to design trend data when developing a product's detailed ideas and drawing idea sketches	88
	• Unrelated material can bring inspiration when generating new ideas, especially for appearance development	59
	• Consumer behaviour or new culture data contributes to the development of a detailed NPD concept	29
	• Competitors' data is used to check the new product's merits and faults	12

Engineering	• Finding opportunities using new technology data is implemented to check whether the new ideas fit the prototype	57
	• Competitors' data is used to check the new product's merits and faults	29
	• No matter how good an idea is, it should meet the budget and regulations	29
	• A detailed product concept also needs to meet consumer needs	14

Table 53. Qualitative study findings on the data frequently used in the development stage

(3) Nature of data use (resources): from where DII are collected

This interview question focused on two issues related to the nature of data resources use when generating ideas: (1) how important and (2) how effective are 7 types of data resources (i.e., internal resource expert, external resource expert, internal database site, external database site, web search engine site, journal or article, other).

'Internal experts' means the data from the internal research division of the interviewee's company. 'External experts' means the data generated by professional research firms outside of their company (outsourcing). 'Internal database' means the database site accessible only to the company's staff via the intranet. 'External database' means a database site that offers specific database sources to the public or members who pay.

(3-1) Importance: which DII resources are important for idea generation? (Interview Q: D.3.1)

In general, the result of this question indicated that three sample teams in the main study commonly agreed with the high importance of the internal expert's data (see Table 54 and Appendix 19-1).

50% of the planning team in the main study believed that their internal experts' data have adequate timeliness and accuracy, as their companies have many research organisations around the world to investigate the latest markets and design trends in each region. In the main study, 59% of designers and 29% of engineers responded that the internal research experts' data were theoretically important, since their role is to offer specific information aligned with company NPD projects goals, which contributes to employees' idea generation (see Table 55).

The findings also showed noticeable dissimilarities between the planning team and the other two teams in the use of external expert's data and web search engine data. Compared with the engineering team, the planning team put greater importance on the external expert's data. On the other hand, the planning team's use of the web search engine site's data was significantly lower than that of the design team (see Table 54 and Appendix 19-2).

According to 82% of the design team respondents in the main study, they can quickly find the latest information on web engine sites. In addition, 43% of engineers in the main study stated the high importance of the internal database site, since they can easily find specific information related to the previous project's practical issues in the site (see Table 55).

Scale
1.Never important 2.Low important 3.Slightly Important 4.moderately important 5.Fairly important 6. Always important

Functions		Internal Resource Expert	External Resource Expert	Internal Database Site	External Database Site	Web Seraching Engine Site	Journal or Article	Other
Planning	Mean	5.70	5.40	4.80	4.70	3.70	3.80	1.00
	Standard Deviation	0.48	0.70	1.14	0.67	1.34	1.40	0.00
Design	Mean	5.24	4.41	4.53	4.18	5.18	4.47	1.47
	Standard Deviation	1.15	1.12	1.07	1.01	1.19	1.18	0.94
Engineering	Mean	4.71	4.00	5.14	4.00	3.86	4.00	1.00
	Standard Deviation	1.38	1.15	0.90	1.29	1.86	1.15	0.00

Table 54. Overall nature of usage of data – important data resource

Function	Contents	Frequency (%) Times Mentioned
Planning	• Consumer lifestyle research is usually conducted by external experts	70
	• Companies have many research organisations around the world to investigate the latest markets and design trends in each region, so the internal experts' data is timely and accurate	50
	• The data from external database sites has objectivity and a more diversified view than the results from internal experts	30
	• The reliability of web search engine sites is low despite the convenient search algorithms as there is a significant amount of unverified information	20
	• Staff can easily find the information related to company projects in the internal database whenever they want	10
Design	• The newest information can be searched using web search engine sites	82
	• Internal research experts need to offer specific information and data suitable for NPD projects, then it can better contribute to idea generation	59
	• Web search engine sites help designers to save time as they have optimised search algorithms	47

	• Recent trends can be found in journals or magazines	12
	• Staff can easily find the information related to company projects in the internal database site whenever they want	6
Engineering	• Staff can easily find the information related to the previous project's practical issues in the internal database	43
	• Internal research experts need to offer specific information and data suitable for NPD projects in order to contribute to idea generation	29
	• All resources are important as they provide differing views of the information	29
	• The data from external database sites has objectivity and a more diversified view than the results from internal experts	14
	• The reliability of web search engine sites is low as there is a significant amount of unverified information	14

Table 55. Qualitative study findings on the important data resource

(3-2) Effectiveness: which DII resources are effective for idea generation? (Interview Q: D.3.1)

The findings related to the effective data resources have illustrated various differences between the three functional teams in the main study. The planning team put greater emphasis on using the data from the internal or external experts compared to the other teams, whereas the design team made effective use of the data not filtered by the experts or database systems, such as the raw data obtained from the web search engine. The engineering team stated a high level of efficiency in using the internal database compared with the other teams (see Table 56 and Appendix 20-1).

Specifically, there was a significant difference in the data from the internal experts between the planning team and the other two teams (see Table 56 and Appendix 20-2). Of respondents from the main study planning team, 60% observed that this is because the internal researchers can offer more specific information based on their full comprehension of NPD projects and business goals, whilst 24% of designers and 29% of engineers noted a lesser level of usefulness of internal data resources, due to its typical large size and redundant content (see Table 57).

Scale
1.Never effective 2.Low effective 3.Slightly effective 4.moderately effective 5.Fairly effective 6. Always effective

Functions		Internal Resource Expert	External Resource Expert	Internal Database Site	External Database Site	Web Seraching Engine Site	Journal or Article	Other
Planning	Mean	4.90	5.50	3.40	4.50	5.00	3.80	1.00
	Standard Deviation	0.74	0.71	1.07	1.18	0.82	1.55	0.00
Design	Mean	3.82	3.76	3.59	4.29	5.76	5.06	1.65

	Standard Deviation	0.95	1.39	0.87	1.31	0.44	1.09	1.27
Engineering	Mean	3.29	4.43	4.71	4.29	3.71	3.14	1.00
	Standard Deviation	0.76	1.51	0.95	1.80	1.89	1.68	0.00

Table 56. Overall nature of usage of data – effective data resource

Function	Contents	Frequency (%) Times Mentioned
Planning	• Internal research experts offer more specific information closely related to NPD projects	60
	• External experts have diverse case study experiences, which is helpful for consumer research	40
	• The newest information can be sourced from web search engine sites	40
	• The data from external expert sites has objectivity and a more varied view than the results from internal experts	30
Design	• The newest information can be sourced from web search engine sites	71
	• Various opinions from diverse groups are objectively presented in web search engine sites	41
	• Recent trends can be found in journals or magazines	29
	• The data from web search engine sites enables people to save time as they have excellent search algorithms	29
	• The size of internal data is too big and duplicated	24
	• Sometimes, using a mobile image app is useful because it is easy to access and save	12
Engineering	• Staff can easily find the information related to company projects in the internal database site whenever they want	57
	• The data from external expert sites has objectivity and a more varied view than the results from internal experts	57
	• The reliability of web search engine sites is low despite the convenient search algorithms as there is a significant amount of unverified information	29
	• The size of internal data is too big and often duplicated	29

Table 57. Qualitative study findings on the effective data resource

(3-3) Frequency: which DII resources do the three sample teams frequently use for idea generation? (Interview Q: D.3.2)

This study investigated the actual use of the data resources in the early part of NPD stage by stage in order to identify the similarities and differences among various functional divisions.

1) Focus Stage

In general, the results of all three sample groups of the main study showed a high level of using data from web search engine sites in the focus stage (see Table 58 and Appendix 21-1). The common and main reason was its fast update of the newest information (see Table 59). The planning team noticeably used the internal and external expert's data much more than the engineering and design teams did, a result similar to that of the question about effectiveness.

Another significant gap was revealed in the use of journals and articles data. The result indicated that designers used journal and article data much more often in the focus stage compared to the other teams (see Table 58 and Appendix 21-2).

Scale

1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Internal Resource Expert	External Resource Expert	Internal Database Site	External Database Site	Web Serarching Engine Site	Journal or Article	Other
Planning	Mean	5.50	5.30	4.50	4.80	5.70	3.50	1.00
	Standard Deviation	0.85	0.82	1.27	1.14	0.48	1.18	0.00
Design	Mean	4.65	4.06	3.71	4.29	5.59	4.65	1.29
	Standard Deviation	0.86	1.20	1.16	1.45	1.23	1.37	0.69
Engineering	Mean	4.14	4.00	4.86	4.71	5.29	3.14	1.00
	Standard Deviation	0.69	1.63	1.07	1.11	0.95	1.35	0.00

Table 58. Overall nature of usage of data – data resources frequently used in the focus stage

Function	Contents	Frequency (%) Times Mentioned
Planning	• The newest information can be sourced from web search engine sites	50
	• Global internal research groups mainly investigate the market or design trends in their region, so it is timely and accurate	30
	• External experts have diverse case study experiences, which is helpful for a starting point	30
Design	• The newest information can be sourced from web search engine sites	47
	• Various opinions from diverse groups are objectively presented in web search engine sites	29
	• Recent trends can be found in journals or magazines	24
	• The size of internal data is too big, general, abstract and duplicated	18
	• The reliability of web search engine sites is low as there is a significant amount of unverified information	6
Engineering	• The newest information can be sourced from web search engine sites	43
	• The size of internal data is too big and duplicated	43

	• Staff can easily find the information related to a recent project's practical issues in the internal database site whenever they want	29
	• The reliability of web search engine sites is low despite the convenient search algorithms as there is a significant amount of unverified information	29

Table 59. Qualitative study findings on the data resources frequently used in the focus stage

2) Direction Stage

The results of the direction stage were similar to those of the focus stage. The planning team in the main study frequently used internal and external experts' data compared to the other teams, and the design team used journal and article data much more than the other teams did. In the direction stage, a significant gap emerged in the use of web search engine sites between the design team and the other teams (see Table 60 and Appendix 22-2).

In particular, the contrasting view of the internal expert's data was clearly indicated in the answers between the planning and the other teams. While 70% of the planning team's respondents in the main study indicated the benefit of the internal data (specific information closely related to the NPD business goal), 76% of the design team respondents of the main study revealed doubts on the results of the internal data, due to its subjective method of analysis. Also, 57% of engineers in the main study noted that the data from internal experts was often too general (see Table 61).

Scale
1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Internal Resource Expert	External Resource Expert	Internal Database Site	External Database Site	Web Serachin g Engine Site	Journal or Article	Other
Planning	Mean	5.90	4.80	3.60	3.60	3.40	3.10	1.00
	Standard Deviation	0.32	0.92	0.97	0.97	0.97	1.20	0.00
Design	Mean	4.24	3.59	3.29	3.47	5.06	4.12	1.18
	Standard Deviation	1.09	1.42	1.16	1.37	0.97	1.11	0.53
Engineering	Mean	3.57	3.00	3.57	3.86	3.14	2.57	1.00
	Standard Deviation	1.51	1.29	0.98	1.07	1.07	0.53	0.00

Table 60. Overall nature of usage of data – data resources frequently used in the direction stage

Function	Contents	Frequency (%) Times Mentioned
Planning	• Internal research experts offer more specific information closely related to NPD projects and business goals	70
	• Consumer lifestyle research is usually conducted by external experts who have diverse case study experiences	50
	• Global internal research experts mainly investigate the market or design trends in their region, so it is timely and accurate	20
Design	• People dealing with practice often mistrust the subjective analysis and results of internal data	76
	• Various opinions from diverse groups are objectively presented in web search engine sites and this inspires new insights	47
	• The data from internal experts is too general	35
	• The newest information can be sourced from web search engine sites	12
Engineering	• The data from internal experts is too general	57
	• Usually engineers refer to the report papers to clarify existing issues, not to generate new ideas	43

Table 61. Qualitative study findings on the data resources frequently used in the direction stage

3) Development Stage

Most of all, the results on the development stage indicated a significant gap in using internal data between the planning and design/engineering teams (see Table 62 and Appendix 23-2). For example, according to 43% of engineering team interviewees in the main study, they refer to internal information to check existing practical issues, rather than to generate novel ideas (see Table 63).

Also, the design team's level of using web search engines and journal and article data in the development stage was significantly higher compared with the other two teams (see Table 62 and Appendix 23-2). Of design team interviewees in the main study, 59% responded that the web search engine has a convenient algorithm for getting the newest information and image data (see Table 63).

Scale
1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Internal Resource Expert	External Resource Expert	Internal Database Site	External Database Site	Web Serching Engine Site	Journal or Article	Other
Planning	Mean	5.30	3.90	3.50	4.00	5.00	2.90	1.00
	Standard Deviation	0.67	1.37	1.43	1.49	1.15	1.10	0.00
Design	Mean	2.94	3.00	3.29	4.18	5.88	5.18	1.82
	Standard Deviation	1.03	1.06	1.10	1.51	0.33	0.81	1.55
Engineering	Mean	2.57	3.86	4.00	4.14	4.14	3.43	1.00
	Standard Deviation	0.79	1.07	1.00	1.77	1.21	0.98	0.00

Table 62. Overall nature of usage of data – data resources frequently used in the development stage

Function	Contents	Frequency (%) Times Mentioned
Planning	• Internal research experts offer more specific information directly related to NPD projects and business goals	60
	• The newest trends can be easily sourced using web search engine sites	50
Design	• The newest information can be easily sourced from web search engine sites	59
	• People dealing with practice often mistrust the analysis results of the internal data	35
	• The data from internal experts is too general or abstract	24
	• Images stimulating new design concepts are often presented from websites or mobile applications	12
Engineering	• Engineers refer to the internal information to clarify existing issues, not to generate new ideas	43
	• The data from external experts' sites introduce new technology trends	43
	• People dealing with practice often mistrust the analysis results of the internal data	29

Table 63. Qualitative study findings on the data resources frequently used in the development stage

(4) Nature of data use (formats): which types of DII format do sample teams use to stimulate idea generation?

This study asked interviewees from three sample groups two sets of questions linked to the nature of their use of data formats when generating ideas: (1) how important and (2) how effective were 6 types of data formats (i.e., image, text, video, real-sample, explanation, other).

(4-1) Importance: which DII formats are important for idea generation? (Interview Q: D.4.1.)

All three sample groups in the main study indicated both image and text data formats to be highly important (see Table 64). However, the importance of text data for the planning team was significantly higher than for the design team, and the result of the image data was vice versa between them (see Appendix 24-1 and 24-2). Of the interviewees from the planning team in the main study, 60% believe that text data format can describe details of issues or context compared with other formats, while 65% of design team respondents said that image data can show various information in one source. In addition, 76% of designers and 43% of engineers of the main study responded that image data are good for sharing new ideas across people in a short time (see Table 65). Also, the engineering team's result using real sample data was noticeably higher than that of the other teams. Regarding this result, 29% of engineers responded that seeing a real sample is the most accurate way to check existing issues (see Table 64 and 65).

Scale
1.Never important 2.Low important 3.Slightly Important 4.moderately important 5.Fairly important 6. Always important

Functions		Image	Text	Video	Real-Sample	Explanation	Other
Planning	Mean	5.10	5.70	4.40	4.10	3.40	1.00
	Standard Deviation	0.74	0.48	1.35	0.74	1.26	0.00
Design	Mean	5.94	4.82	5.12	4.59	3.29	1.00
	Standard Deviation	0.24	0.81	1.05	1.28	1.16	0.00
Engineering	Mean	5.71	5.29	5.00	5.71	3.57	1.00
	Standard Deviation	0.49	0.95	0.82	0.49	1.40	0.00

Table 64. Overall nature of usage of data – important data formats

Function	Contents	Frequency (%) Times Mentioned
Planning	• Text data format can present details of issues and context	60
	• Both text and image data are important as they are the basis of all data formats	50
	• Image data can support and supplement text data	30
	• Video is used more often than before as it is easy to share complicated ideas	10
Design	• Image data makes it easy to share the ideas in real time	76
	• Image data can show a variety of information in one source	65
	• Video is used more often than before as it is easy to share complicated ideas	18
	• All data formats are important	18
	• Watching videos is better than reading text to comprehend context as it can even provide emotional context	18
	• Both text and image data are important as they are the basis of all data formats	12
Engineering	• Image data makes it easy to share ideas in real time	43
	• Both text and image data are important as they are the basis of all data formats	29
	• Seeing real samples is the most accurate way to check existing issues	29
	• All data formats are important	29

Table 65. Qualitative study findings on the important data formats

(4-2) Effectiveness: which DII formats are effective for idea generation? (Interview Q: D.4.1.)

The results on effective formats when generating ideas were similar to that of importance. The planning team's result illustrated a high level of efficiency when using text-formatted data, and the design team showed a high level of effectiveness when using image-formatted data. Compared to the other teams, engineering team believed that using real samples is very useful for generating ideas (see Table 66 and Appendix 25-1).

Furthermore, the design team also stated a high level of effectiveness of video data compared with the others (see Table 66): 53% of them in the main study said that video formats make it easy to share complicated ideas and to enable people to comprehend the context, including emotional content (see Table 67).

Scale
1.Never effective 2.Low effective 3.Slightly effective 4.moderately effective 5.Fairly effective 6. Always effective

Functions		Image	Text	Video	Real-Sample	Explanation	Other
Planning	Mean	5.10	5.40	3.80	4.00	2.90	1.00
	Standard Deviation	0.74	0.84	1.69	1.05	1.29	0.00
Design	Mean	5.88	4.24	5.18	4.59	3.24	1.00
	Standard Deviation	0.33	1.03	1.01	1.37	0.97	0.00
Engineering	Mean	5.43	4.29	4.29	5.86	4.29	1.00
	Standard Deviation	0.53	0.95	1.11	0.38	1.70	0.00

Table 66. Overall nature of usage of data – effective data formats

Function	Contents	Frequency (%) Times Mentioned
Planning	• Text data format can present more context and details of issues	80
	• Image data can support the text data	50
	• Practice-based teams don't read the text generated from research teams properly	20
	• Explanation method is not efficient as it is not easy to get the information at the time it is required	10
	• Seeing real samples would be an accurate way to check issues, but it is not easy to obtain samples every time	10
Design	• Image data can show a variety of information in one source	71
	• Watching videos is better than reading text to comprehend context as it can even provide emotional context	53
	• Image data often gives inspiration for the creation of new ideas	35

	• Video is used more often than before as it is easy to share complicated ideas	35
	• The internal data (mainly offered in text format) is too big and duplicated	29
	• Image data makes it easy to share ideas in real time	29
	• An efficient format for sharing data among different teams is needed	18
Engineering	• Seeing real samples is the most accurate way to check issues as they arise	71
	• Image data makes it easy to share ideas in real time	43
	• An efficient format for sharing data among different teams is needed	14
	• Not enough time to read all details of the issues	14

Table 67. Qualitative study findings on the effective data formats

(4-3) Frequency: which DII formats do the three sample teams frequently use for idea generation? (Interview Q: D.4.2)

This question was designed to discover the actual use of data formats between three main study sample teams when generating and developing ideas.

1) Focus Stage

The focus stage results revealed that the three main study sample groups commonly used image and text formatted data often when embarking on NPD, but the level of the design team's use of text formatted data was noticeably less than other teams (see Table 68 and Appendix 26-2).

In a subsequent qualitative interview, 59% of the total interviewees in the main study stated that using both text and image data is the basic way to begin research (planning: 50%, design: 65%, engineering: 57%). Also, 53% of the design team's interviewees were concerned about insufficient time to read large amounts of text-formatted data (see Table 69).

Scale
1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Image	Text	Video	Real-Sample	Explanation	Other
Planning	Mean	5.40	6.00	3.00	2.60	2.90	1.00
	Standard Deviation	0.84	0.00	0.82	1.17	1.37	0.00
Design	Mean	5.76	5.41	3.71	2.94	2.29	1.00
	Standard Deviation	0.56	0.80	1.40	1.34	1.05	0.00
Engineering	Mean	5.43	6.00	3.00	3.71	3.29	1.00
	Standard Deviation	0.79	0.00	1.00	1.50	1.25	0.00

Table 68. Overall nature of usage of data – data formats frequently used in the focus stage

Function	Contents	Frequency (%) Times Mentioned
Planning	• Text data format can present details of issues and context	60
	• Text and image data formats are the basis of all data formats	50
	• Text data is the basic format for research	30
Design	• Text and image data formats are the basis of all data formats	65
	• Not enough time to read all details of issues	53
	• Image data often gives inspiration for the creation of new ideas	35
	• Image data can show a variety of information in one source	18
Engineering	• Text and image data formats are the basis of all data formats	57
	• Text data format can present details of issues and context	43

Table 69. Qualitative study findings on the data formats frequently used in the focus stage

2) Direction Stage

There was a significant difference in the findings between the three functional teams in the direction stage. The planning team used image-formatted data much less than the design team, and the design team typically used text formatted data much less than the other teams (see Table 70 and Appendix 27-2).

Of respondents from the planning team in the main study, 90% said that text can deliver details of the context related to the NPD concept, while 59% of design team interviewees were stated that the content written in text format from the research division are often too abstract. On the other hand, 86% of engineers in the main study agreed on the usefulness of both text and image-formatted data, since they comprise the fundamental format of research (see Table 71).

Scale
1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Image	Text	Video	Real-Sample	Explanation	Other
Planning	Mean	4.40	6.00	3.30	3.00	2.40	1.00
	Standard Deviation	1.26	0.00	1.34	0.82	0.52	0.00
Design	Mean	5.71	4.94	3.47	2.94	3.35	1.00
	Standard Deviation	0.47	1.14	1.12	1.09	1.27	0.00
Engineering	Mean	5.71	6.00	2.71	3.43	3.86	1.00
	Standard Deviation	0.49	0.00	1.11	1.13	1.21	0.00

Table 70. Overall nature of usage of data – data formats frequently used in the direction stage

Function	Contents	Frequency (%) Times Mentioned
Planning	• Text data format can present details of NPD concept	90
	• Designers do not want to read text data in detail	30
	• Text and image data is the basis of data formats	10
Design	• Some explanation written in text from internal research team is too abstract	59
	• Image data can show a variety of information in one source	53
	• Not enough time to read all details of issues	41
	• Text data format can present more context and details of the NPD concept	24
	• The internal data is mainly presented in text formats with too much quantity and is often duplicated	18
	• Watching videos is better than reading text to comprehend context as it can even provide emotional context	18
	• Text and image data formats are the basis of all data formats	12
Engineering	• Text and image data formats are the basis of all data formats	86
	• Not enough time to read all details of issues	29
	• Some explanations written in text are too abstract	14

Table 71. Qualitative study findings on the data formats frequently used in the direction stage

3) Development Stage

In the development stage, the results of each type of data format showed significant dissimilarities between the three functional teams (see Table 72 and Appendix 28-2). The level of the planning teams use of image-formatted data was noticeably lower compared to the other two teams, and the design team’s use of text-formatted data was much lower than that of the others. Of design team participants in the main study, 53% indicated that using image data often inspires them when creating new ideas. Compared to the planning and engineering teams, the design team frequently used video-formatted data in a variety of ways in the development stage (see Table 73).

Also, the engineering team explained the benefit of verbal explanations for sharing information. According to 57% of engineering interviewees in the main study, technology issues are difficult to understand by just reading a text, especially for those who lack engineering knowledge. For this reason, they think verbal explanation is the easiest way for people to understand technology issues.

Scale
1.Never use 2.Low use 3.Slightly use 4.moderately use 5.Fairly use 6. Always use

Functions		Image	Text	Video	Real-Sample	Explanation	Other
Planning	Mean	5.40	6.00	3.40	3.40	3.20	1.00
	Standard Deviation	0.52	0.00	1.43	0.97	1.32	0.00
Design	Mean	6.00	3.71	4.65	3.53	3.06	1.00
	Standard Deviation	0.00	0.92	0.86	1.42	1.43	0.00
Engineering	Mean	6.00	5.86	2.71	4.86	5.57	1.00
	Standard Deviation	0.00	0.38	1.38	1.07	1.13	0.00

Table 72. Overall nature of usage of data – data formats frequently used in the development stage

Function	Contents	Frequency (%) Times Mentioned
Planning	• Text and image data formats are the basis of all data formats	70
	• Text data format can present details of related issues and context	50
	• Explanation method takes too much time	20
Design	• Image and video data can show a variety of information in one source	59
	• Image data often gives inspiration for the creation of new ideas	53
	• Not enough time to read all details of the issues	29
	• The internal data is mainly presented in text format with too much quantity and is often duplicated	24
	• Watching videos is better than reading text to comprehend context as it can even provide emotional context	24
	• Sometimes, the design team films the video themselves to explain details of the design concept, including emotional context, to others or decision makers	12
	• Seeing a real sample would be an accurate way to check issues, but it is not easy to obtain samples every time	6
Engineering	• Text and image data formats are the basis of all data formats	57
	• A verbal explanation is the easiest way to enable people who don’t have technological expertise understand the content	57
	• Image data can show a variety of information in one source	43
	• Seeing a real sample is the most accurate way to check issues	29
	• Not enough time to read all details of the issues	29

Table 73. Qualitative study findings on the data formats frequently used in the development stage

(5) Frequency of internal data use (Interview Q: D.5)

The aim of this question was to identify each team's level of use of internal data and to discover any emergent gaps between them. Specifically, the result showed a significant difference between the research-based team (planning) and practice-based teams (design, engineering). Respondents from design and engineering teams in the main study indicated that they use less than 40% of all internal data given from research-based teams, whereas planning team interviewees stated that they use at least more than 60% of it (see Table 74).

In the subsequent qualitative interviews with main study participants, interviewees from all three teams were mistrustful of each other. Fifty percent of planning team interviewees noticed the design and engineering teams' low level of using internal materials, and 30% of them were also concerned with the designers' over-reliance on intuitional or emotional approaches to generating ideas (see Table 75).

On the other hand, the main study's design and engineering team interviewees revealed a mistrust of the results from the internal material. According to 82% of designers and 43% of engineers in the main study, the qualitative data in the internal materials are largely affected by the researchers' subjective view, so that they cannot easily agree with their outcomes. Furthermore, 54% of designers and engineers in the main study also indicated that the information from internal data is often too general and abstract for obtaining specific inspiration (design: 59%, engineering: 43%). Also, 57% of engineers pointed that it is not easy to understand the context of the NPD concept by reading the materials only. Its massive size and the limited development time often affected the low level of using internal data too (see Table 75).

percent of usage	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%
Planning	0%	0%	0%	0%	0%	0%	10%	40%	50%	0%
Design	12%	29%	29%	29%	0%	0%	0%	0%	0%	0%
Engineering	29%	14%	43%	14%	0%	0%	0%	0%	0%	0%

Table 74. Frequency of using internal data

Function	Contents	Frequency (%) Times Mentioned
Planning	• Internal data includes accurate information and key points, since it's created by the groups that have in-depth understanding of the NPD theme and company's business	80
	• Practice-based teams usually do not refer to the material from the research division	50

	• Designers mainly rely on emotion or intuition to generate ideas	30
	• Some research content is duplicated as there are many separate research teams in the company	10
Design	• The result of qualitative data is analysed largely based on the researchers' subjective view	82
	• The content of the internal data is too general or abstract	59
	• The size of the data is too large and often duplicated	41
	• Research division and decision makers tend to not agree with the idea without numerical evidence or robust logic	24
	• It is not easy to understand the context of the NPD concept properly by only reading the results in text format	24
Engineering	• It is not easy to understand the context of the NPD concept properly by only reading the results in text format	57
	• The content of the internal data is too general or abstract	43
	• The result of qualitative data is analysed largely based on the researchers' subjective view	43
	• There is no time to read all the material	29
	• The size of the data is too large and often duplicated	29

Table 75. Qualitative study findings on the frequency of using internal data

Key findings

This study identified following key issues related to the nature of the use of the data when generating and developing ideas:

- A team's role in the NPD process and its expertise are linked to the team's approach in how it uses data, information, and insights (DII)
- A lack of understanding of other teams' methods of using DII to generate ideas can lead to mistrust and can potentially create conflicts between teams
- Mistrust can result in a lack of effective use of a company's internal research data when developing new products
- The methods of using data to stimulate the creation of new ideas are different between each of the expert groups, and therefore the quality of synthesised ideas (i.e. ideas established by integration of each team's ideas) can potentially be improved if each expert group freely uses their preferred data and data use methods

4.2.5. Summary of Main Study Findings

The purpose of the main study was to identify factors affecting mistrust and uncertainty in the idea generation process of NPD. It has identified the following key issues related to each sub-theme:

A. Ideas and the Nature of the Idea Generation Process

Summary of emergent issues:

- Team's role and leadership style of a manager have a direct impact on the performance (positive and negative) of the idea generation activities
- A top-down structured approach appears to create mistrust between the planning and the design and engineering teams
- Diverse perspectives between the different teams on defining idea quality can contribute to disagreements and mistrust between the functions

This study identified that recent idea generation processes are conducted under an official but flexible environment in which a manager often controls detailed schedules and the direction of work. For this reason, team's role and leadership style of a manager can directly affect the overall performance of the idea generation activities. Also, this study discovered that, because of the hierarchical top-down structured process, design and engineering teams are not often involved in selecting and defining idea quality. In addition, this apparent top-down approach appears to create mistrust between the planning and the design and engineering teams. Varying perspectives on identifying ideas between different teams can bring disagreements; and, within the top-down system, the design and engineering teams have to develop the selected ideas, even though they may not agree with the selected ideas.

B. NPD Initiation and People's Involvement

Summary of emergent issues:

- Blended factors mainly related to consumer behaviour and needs, including emotional attraction, are key determinants of success or failure in developing new products in current markets
- A lack of communication and feedback exchange among diverse teams expands the gap between their perspectives on the information discovered, which leads to mistrust between the teams
- Mistrust reduces the overall contribution of the research team's data and results to the development of new products
- The highest level of mistrust between diverse expert teams can specifically emerge from the different perspectives on consumer data, since consumer feedback appears to be a core element when building a product concept in current MNEs' NPD processes (e.g. implementing multiple consumer clinics across ES NPD to get consumer feedback)

This study identified that, to a significant degree, all three teams consider consumer data as a factor that affects successful NPD. Also, this study found that a lack of communication between the planning and the design and engineering teams causes mistrust between them. That is because the absence of communication and feedback exchange can hinder any chances to integrate different perspectives when generating and developing ideas. Companies seem to try to integrate different types of knowledge through cross-functional meetings or multidisciplinary teams, but employees doubt their effectiveness. In addition, the design and engineering teams do not use the information analysed by the research division effectively due to their mistrust of it. Furthermore, this study showed that the potential for the highest level of mistrust between teams is linked with consumer data, since consumer feedback seems to be the core element in building product concepts in current MNEs' NPD processes.

C. Uncertainty in Idea Generation

Summary of emergent issues:

- A team's role in NPD projects and its own perspectives on selecting and defining idea quality affects the levels of and reasons for uncertainty in the idea generation stage of NPD

- Understanding of other teams' different roles and perspectives in NPD can contribute to reducing mistrust and uncertainty in the idea generation stage

The study found that the difference in the nature of uncertainty between the three sample groups comes from the gap in perspectives of selecting and defining idea quality and their different roles in NPD. Specifically, these findings showed that a lack of understanding of other teams' divergent perspectives and roles engenders higher levels of mistrust between different types of teams, which causes increased levels of uncertainty when generating ideas. For example, the design and engineering teams revealed a greater understanding of each other's roles and perspectives in the early stage of NPD, but they indicated a lower level of trust in the planning teams due to less communication and understanding of each other's roles and perspectives.

D. Data, Information and Insights (DII) that Stimulate Generating Ideas

Summary of emergent issues:

- A team's role in the NPD process and its expertise are linked to the team's approach in how it uses data, information, and insights (DII)
- A lack of understanding of other teams' methods of using DII to generate ideas can lead to mistrust and can potentially create conflicts between teams
- Mistrust can result in a lack of effective use of a company's internal research data when developing new products
- The methods of using data to stimulate the creation of new ideas are different between each of the expert groups, and therefore the quality of synthesised ideas (i.e. ideas established by integration of each team's ideas) can potentially be improved if each expert group freely uses their preferred data and data use methods

The study of how data, information, and insights used to stimulate the idea-generation process, identified that employees generally focus on their own expertise and role in NPD when collecting and analysing data. In particular, this study discovered that the inconsistency in the ways of using data and getting insights results in mistrust, and the mistrust between different functional teams causes inefficient use of companies' internal research data in NPD practice.

In addition, this study discovered that the methods of using data to stimulate the creation of new ideas are different between each expert group. Each team's idea forms the basis of the synthesised idea, and therefore the findings revealed that the quality of synthesised ideas could potentially be improved when each expert group freely uses their preferred data and data use methods.

4.3. Validation Study

The validation study implemented a programme of rigorous and systematic interviews in order to validate the findings of the main research. The validation interviews set out to explore ‘why’ and ‘how’ questions so as to better understand the drivers and factors influencing the validated responses.

A representative sample of 12 interviewees is drawn from the planning team (4), design team (4), and engineering team (4) across the four industrial MNEs.

The validation study adopted a qualitative-centred methodology using content analysis. The use of structured in-depth interviews with participants has enabled the identification of a series of common and specified reasons for emergent issues (Holsti, 1969, p.14).

4.3.1. Ideas and the Nature of Idea Generation Process

(1) Nature of the idea generation process

(1-1) Length of idea generation and development process (Interview Q: A.1)

A total of 100% of respondents, representing all three teams, agreed on the findings of the main study about the time schedule of the idea generation and development stages. Although the total NPD period could vary depending on project types, they confirmed that the idea generation and development period consistently accounted for around 50% of the total NPD journey.

For example, the idea generation and development stages for vehicles (e.g. sedan or SUV) generally take 21–24 months of the entire NPD process period of 42–48 months. Similarly, parallel activities with consumer smart electronics (e.g. mobile phone, television, or tablet PC) routinely take approximately 9-12 months of the total NPD process period of 18–24 months.

(1-2) Nature of the idea generation process (Interview Q: A.4)

The findings of the main interview showed that the typical NPD processes of MNEs generally run under the official schedule with a top-down structure and team-based tasks. Also, project managers flexibly adjust the detailed schedule. A total of 100% of the interviewees from the validation interview agreed on the findings of the main study, and 58% of the total respondents (planning: 100%, design: 25%, engineering: 50%) showed the need for more practically structured processes. According to the 58% of respondents, although the company holds idea generation meetings with cross-functional teams in the early stage of the idea generation phase, no one carefully follows up the outcomes from the meetings. This appears to be linked to companies not having the correct processes and practices to give appropriate rewards for the meeting's performance targets.

A total of 100% of the design team respondents believed that designers do more individual work than the other teams, as they normally create visual outcomes alone via their own methodologies. The design team members explained that they mainly spend their time on searching for relevant data and drawing idea sketches, and then bring the results to their managers. During these activities, team meetings are held regularly to discuss common design themes. In contrast, planning and engineering teams confirmed that their working processes are mainly implemented via collaborative rather than individual approaches.

(2) Importance of the idea generation stage and Ideas

(2-1) Level of importance of the idea generation stage (Interview Q: A.2)

All three groups agreed to the high level of importance of the idea generation stage (front end) in NPD. They confirmed that the main reason for this importance relates to the fact that it is harder and more costly to adjust product direction after the product concept is fixed. Of respondents from the design and engineering teams, 75% agreed on the impact of the front-end stage on the later stages. For example, when designers or engineers mistrust the product concept, the level of doubt about it affects their level of satisfaction in their practical works while developing ideas. One interview participant from an engineering team provided an insightful overview of this validated issue:

> *"…When the company embarked on NPD for a target consumer who considered brand value, the planning team was more focused on establishing new brand value than thinking about changes in product specifications.*
>
> *In other words, the new model looked different from the previous cheaper model, but it had virtually similar specifications. Thus, from the designers'*

and engineers' perspectives, the concept of the product was abstract or unreasonable. While developing NPD, designers and engineers doubted why consumers would pay more for the new model. In the end, the sales result of the new model was very poor…."

(Participant No. 2 in Engineering team)

(2-2) Idea quantity vs. Idea Quality (Interview Q: A.3)

The validation interview showed a comparable result with that of the main interview: 83% of all validation interviewees agreed with the outcomes of the main study – that both idea quality and quantity are important, but the quality is marginally more important.

A clear majority of the planning team's respondents in the validation study (75%) answered that their companies make great efforts to increase idea quality. They consult external professionals about generating new ideas using the experts' special tools, or create internal expert groups that focus only on facilitating new ideas. According to the 75% of respondents, the idea generation sessions with the external or internal experts were helpful for synthesising various ideas, especially in multidisciplinary groups. However, despite the positive benefits, they have not been implemented often enough in recent projects, as the companies experienced difficulties in using the sessions due to lack of time and the vague scope of people involved. Seventy-five per cent of interviewees from design teams (validation study) agreed the main study's outcome from design team; they had experienced dissatisfaction when they had to generate more ideas without thinking about their quality due to the demands of their managers.

(3) Defining idea quality (Interview Q: A.5)

In the validation interview, the three functional teams all agreed with the following three outcomes of the main interview question: 1) the preferences of each team when defining idea quality are deeply related to the team members' main roles at the early stage of NPD; 2) the business goal is the main factor greatly considered in actually defining idea quality work, even though all three teams are aware of it being less effective; and 3) different functional teams have different perspectives when defining ideas, which causes conflicts and mistrust between them.

According to 83% of the respondents in the validation study, defining idea quality means selecting good ideas. For this reason, they agreed that, when choosing good ideas, people naturally prefer familiar factors linked to their personal knowledge and work activities. In this regard, 50% of respondents from the engineering team in the validation study stated that the NPD results were usually successful when the engineers had sufficient confidence in the feasibility of the new technology scenarios. However, in actual NPD projects, directors who consider business goals seriously usually select main ideas that include the safest path to conventionally successful outcomes in order to avoid huge risks (75% of the interviewees in the validation study were concerned that overly focusing on the business goal causes ideas to become general).

All of the interviewees in the validation study showed that they were aware of the different perspectives on idea quality between the different teams. According to them, the design team focuses on newness and the engineering team mainly considers feasibility and validity, while the planning team focuses on numerical evidence. The interviewees mentioned in particular the gap between the planning and design teams: the former usually acquires new insight from rational or logical analysis of existing factors, whereas designers are easily inspired by personal intuition without evidence or by emotional facts. In addition, 75% of design team respondents in the validation study mentioned that they often face difficulties when talking to other teams (especially planning teams, as they usually ask for evidence to support the designer’s idea, while designers frequently reinterpret information using their personal experiences and gut feelings; see Table 76).

For example:

> *“…When we had joint work with the planning team to obtain insight from consumer interview results, the planning team focused on the fact that ‘25 out of 30 people like option A’, while designers thought ‘why five people prefer option B’…..”*
>
> *(Participant No. 1 in the design team)*

The results of this study showed that the three sample groups had some awareness of how languages are different between diverse expert teams (see Table 76). Of the respondents in the validation interview, 92% agreed that the lack of a common language causes uncertainty in projects and mistrust between different teams, which affects the engendering of innovative ideas and the development of opportunities.

	Planning	Design	Engineering
Character of Different Language	- Numerical Evidence - Rational - Logical	- Personal Intuition and Experience - Emotional - Seeking 'New'	- Feasibility - Validity

Table 76. Summary of character of each team's language

4.3.2. NPD Initiation and People Involvement

(1) Reason for the initiation of new projects (Interview Q: B.1)

The main study indicated that market circumstances and consumer issues are the most important factors affecting the initiation of NPD activities (83% of the total respondents in the validation study [planning: 100%, design: 100%, engineering: 50%] confirmed the main study's findings). Furthermore, 88% of respondents from the planning and design teams in the validation study addressed that the planning team tends to draw insights from consumer data using exact numerical values, while design teams focus more on obtaining insights from consumer behaviour or new social trends using personal intuition. The respondents stated that, between the two teams, the slightly different results obtained by using consumer data might derive from differences in their way of working and thinking.

Also, 67% of the total respondents (planning: 50%, design: 50%, engineering: 100%) emphasised that new technology became one of the main reasons for starting NPD. According to the validation sample, consumers' lifestyles and social behaviour often follow closely behind new technology as drivers for initiating NPD activities.

(2) People's involvement in idea generation and development stages (Interview Q: B.2/B.3)

The main study identified three main findings linked to the level of team involvement of in the early stages of NPD. Firstly, the level of involvement and the main roles of each functional team in the idea generation and development stages are significantly different. Secondly, the design and engineering teams mistrust the results delivered from the planning team. Thirdly, all three functional teams regarded companies' knowledge integration systems (e.g. cross-functional meetings or multidisciplinary teams) as inefficient, because employees are not motivated due to the lack of a proper rewards system and failure to follow up results. All of the total validation samples agreed with the three key findings above, and they provided primary reasons related to the findings.

Difficulties as a result of lack of communication

According to all validation interviewees, the different involvement levels and roles of each functional team are a natural consequence of large organisations. However, 92% (planning: 100%, design: 100%, engineering: 75%) also agreed on the need for more effective ways of knowledge integration through a higher level of involvement on the part of the practice-based teams. Specifically, 88% of interviewees from the design and engineering teams (design: 100%, engineering: 75%) described that they need a space within the idea generation phase where they can directly embed their insights into the NPD concept. All interviewees from the planning team agreed with the need to adjust current systems in order to create more design and engineering team involvement. However, they were also concerned about how to establish an appropriate number of diverse experts involved in the early stage of NPD, since changes in human resources poses a substantial risk of costs and time in many large organisations.

Mistrust between Research and Practice division

This study found that the desire of design and engineering teams to be involved in idea generation stages is deeply related to their mistrust of the research outcomes from the planning team. In addition, the mistrust was caused potentially by differences in languages – perspectives or ways of generating ideas – between the teams. For example, 63% (design: 75%, engineering: 50%) of design and engineering respondents (validation study) indicated that they cannot understand NPD context from insights obtained by others (research division) due to the different languages. Furthermore, 88% of respondents from design and engineering teams (design: 100%, engineering: 75%) illustrated that the mistrust originally comes from a lack of effective internal communication in the front-end phase, since there are few chances to learn or understand each other's languages. In other words, they need more effective channels to give and receive feedback between different functional teams (especially between planning and practice-based teams) before main ideas are fixed in order to establish a common language.

In the validation study, 75% of design and engineering team respondents said that their level of uncertainty about their ideas would be reduced if they could develop key insights from their own perspectives based on substantial comprehension of the full context of the NPD concept in its early stages.

Current attempts to overcome inefficient knowledge integration system

The main study showed that companies with the sample MNEs have recently tried to integrate different kinds of expertise in the idea generation phase. For example, all of the sample companies perform cross-functional meetings in the early part of the idea generation stage, and 75% of the sample companies facilitate staff exchanges, or have their designers involved in consumer shadowing events. However, 100% of all interviewees in the validation study stated that the companies still need efficient, long-term systems to synthesise various ideas from diverse expert groups.

In addition, the interviewees agreed that the low effectiveness of the recent multidisciplinary approach in the idea generation stage was caused by an improper rewards system. For example, people generally make an effort on the multidisciplinary teams only when the teams are led by a person with authority over their performance appraisal; 83% of interviewees (planning: 75%, design: 75%, engineering: 100%) indicated that recent reward systems need to be revised in order to encourage employees to have ownership through strong motivation, which may enable multidisciplinary approaches to be successful.

4.3.3. Uncertainty in Idea Generation

(1) Level of uncertainty and reasons (Interview Q: C.1/C.2)

All participants in the validation study agreed that their experience of uncertainty relates deeply to the level of people's involvement and their own responsibilities in NPD (they feel the pressure to perform). Also, they confirmed that a lack of comprehension of other experts' views or roles in NPD can foster mistrust and uncertainty in the idea generation stage. In this regard, 83% of interviewees in the validation study pointed out that a lack of opportunities to communicate with other teams in the idea generation stage often causes a lack of understanding.

According to them, continuous and iterative communication between planning and practice-based teams in the idea generation stages would enable the design and engineering teams to start NPD with a precise understanding of the planning team’s intention. Also, planning personnel can easily predict how the product concept will be reflected in reality through an informed understanding of the practice-based team’s role and perspectives.

(2) Reducing Uncertainty through Communication (Interview Q: C.3)

In the validation study, several key issues emerged. Firstly, all interview participants agreed with the diminished effectiveness of recent multidisciplinary teams compared to their importance, due to an inefficient system. Most of the interviewees pointed out that the meeting agenda is the main problem in the multidisciplinary teams. For example, the main activity in the cross-functional meetings is not the suggestion of various options for generating new ideas: people from each functional team usually report a rising issues in their work to directors (which accords with the finding of the main interviews). Secondly, all respondents from the three functional teams confirmed that communication with people who have similar knowledge and perspectives significantly helps to reduce their uncertainty, as those people can easily understand and evaluate the benefit of their ideas. Thirdly, 92% of the interviewees in the validation study indicated the importance of the design team’s role in the idea generation stage. This is linked to the design team’s ability to synthesise disparate elements in order to be able to create new opportunities, which can help attract consumers in the current market, which is a key element for creating blended perspectives.

4.3.4. Data, Information and Insights (DII) that Stimulate Generating Ideas

(1) Data, Information, and Insights (DII) Use Process (Interview Q: D.1)

The results from the main interview indicated that the sample MNEs typically do not operate formal processes for collecting and using data for idea generation. 100% of total validation interviewees agreed to the results of the main interviews, and they also mentioned that strictly formal processes for using data would be harmful to generating innovative ideas, since most of the experts generally want to obtain insights through their own expertise perspectives and methods and then convert the insights to ideas. Of validation interviewees from the planning team, 75% said that they noticed their higher ratio of using indirect data than the other teams, as they often refer to external researchers' data – especially while cooperating with experts via outsourcing. In addition, 83% of total validation interviewees agreed that practice-based teams prefer collecting data themselves rather than using indirect data filtered by others. In validation interviews, 75% of interviewees responded that providing a proper range of data would be helpful in increasing the level of use of the indirect data of practice-based teams, as its vastness is one of the reasons why people in practice divisions do not often refer to the indirect data.

(2) Nature of data use: Content (Interview Q: D.2)

All of the respondents in the validation study agreed with the results from the main interview; consumer data and the data related to their own expertise or responsibilities are commonly the most important for generating ideas. Furthermore, how closely the data are related to the respondents' expertise or responsibilities affects their level of uncertainty.

One hundred per cent of the planning team's interviewees in the validation study agreed on the level of importance and effectiveness of using consumer feedback data, and they also showed satisfaction with recent consumer feedback studies, such as the Initial Quality Study (IQS). On the other hand, 75% of design and engineering team interviewees in the validation study revealed doubts about the planning team's methods for analysing consumer surveys. According to them, since some consumer needs research overly relies on numerical results, companies miss out on specific insights.

> *"…If product A has 15% dissatisfaction and 85% satisfaction, and product B has 10% dissatisfaction and 90% satisfaction, B is evaluated the better product. However, what if consumers are highly satisfied with the 85% of A, but moderately satisfied with the 90% of B? Which one is the better product?..."*
>
> *(Participant No. 3 in the design team)*

One hundred per cent of validation interviewees from the design team agreed on designers' frequent use of data that was unrelated to the NPD theme. According to them, designers can be inspired by various materials more than other functional staff; this is because they have evolved their own methods of creativity through personal experiences and a variety of catalysts over time.

Another interesting finding from the main study was the engineering teams' high use of legal, finance, and environmental data compared with the other two sample teams. In this connection, the validation study found that all sample companies have a legal certification team, which officially belongs to the engineering team. Also, the engineering team mentioned that engineers tend to be conservative when trying completely new approaches because they are in charge of legal and cost issues.

(3) Nature of data use: Resources (Interview Q: D.3)

In the validation study, interview participants actively discussed two themes linked to internal experts' data and web search engines.

Internal Experts' Data

In the validation study, most of the respondents strongly agreed with the following results of the main interviews. Internal expert groups are regarded as an important data resource for all functional teams; however, designers and engineers do not use the internal experts' data effectively for their actual idea generation because they mistrust the analysed results. In particular, from the conversation with practice-based teams, this validation study has confirmed two factors related to the practice-based teams' inefficient use of internal experts' data: insufficient time and mistrust. Firstly, 88% of design and engineering teams pointed out their large size and duplication of content as the main reasons why they often do not use internal experts' data. However, 63% of the design and engineering teams additionally explained that the root cause of the problem is the lack of orientation of data provided. For example, if a range of data was offered for navigating vital information, people could save time when using internal experts' data, which could motivate designers and engineers to use such data for their idea generation processes. Secondly, all the design and engineering team interviewees were mistrustful of the internal data because of different functional perspectives. According to them, the mistrust mainly arises within the qualitative data, such as the results analysed by research-based teams, and they have experienced arguments with the planning team due to disagreements about the results of consumer behaviour or trends data.

Web Search Engine

All three functions interviewed agreed that web search engines are a key resource that they use in the idea generation phase. However, they also questioned the reliability of web search engines. Of the planning team's interviewees, 75% in the validation study said that, since their main works are related to finding logical, numerical evidence with an accurate and in-depth understanding of the market, overly relying on web search engine sites might be risky due to their low reliability. On the other hand, according to 75% of the design team's interviewees, the reliability of web search engine sites does not largely affect their work, unlike other teams, since they often reinterpret raw information through personal experience and emotion rather than directly using the data. Fifty per cent of the engineering team's interviewees preferred using highly reliable database sites more than web search engines for generating ideas. Many design and engineering interviewees (63%) also said that the lack of clear guidance on how to use the various resources may be a reason why many people overly rely on web search engine sites, despite doubting their reliability. For instance, according to one interview participant, it took a long time to even get a user ID and password when their team wanted to use external database sites, because they did not know which team had the log-in information and which teams in their company could access the sites that charged. Another interview participant had similar difficulties using external expert sites because of the complex route to using the company account. Furthermore, employees seemed to feel it was much more convenient to use web search engine sites than the internal database site, due to its advanced search algorithm (e.g. web search engine sites have intelligent platforms that generate specific information based on personal search history and interests).

(4) Nature of data use: Formats (Interview Q: D.4)

The main interview found that the planning team prefers to use text-formatted data when generating ideas, while the design team's preference is image-formatted data. In addition, the engineering team tends to use real samples and verbal explanation when developing ideas more than the other teams. All validation interviewees from the three teams agreed to the results of the main interview; in particular, the design and engineering teams offered examples related to these outcomes. Of respondents from the design team in the validation study, 75%

mentioned that the core factor of why most of the designers prefer image-formatted data is its openness (open-ended data upon which they can easily embed their personal experiences or intuition). In other words, since images usually do not show precise definitions or explanations of information, unlike text-formatted data, designers can easily put their personal point of views, interpretations, and experiences into new ideas with the image data.

Of respondents from the design team in the validation study, 50% also cited the effectiveness of video-formatted data, especially while sharing ideas with other functional teams. For example, they use film or advertisements retrieved from web search engines when explaining design concepts in order to share emotional contents in the concept with other teams. Also, they sometimes film a video of themselves to introduce the concept of the user interface design to directors. According to them, they experienced effective communication with the planning team when they explained their design concept using videos, since understanding design concepts using text or a few images only is too difficult to make sense of, because of the many emotional elements in the design themes.

All of engineering team's interviewees said that verbal explanation is useful and is actually used often, due to the difficulties of technical terms. People from other functional teams often have difficulty understanding the content of technical terms, even though a text-formatted description of the term is written in the materials. In addition, the engineering team showed their preference for using a combination of text and image-formatted data, since simplifying engineering issues through graphics with a short explanation is more helpful in explaining engineering issues than using only one type of format.

(5) Frequency of internal data use (Interview Q: D.5)

Low frequency of using internal qualitative data

In the validation study, 100% of total interviewees showed their recognition that practice-based teams infrequently use companies' internal data. Respondents from the design and engineering teams particularly indicated mistrust of the qualitative data from research-based teams for the same reason as in the main study: the results filtered by the research-based team mainly include subjective insight and are often too general and abstract. In addition, 75% of the design and engineering teams revealed their concern about not comprehending the context or history of the idea concept. According to them, an inadequate understanding of the main concept's context can lead to misunderstanding or suspicion of the research results, causing mistrust. In this connection, 50% of the interviewees from practice-based teams (validation study) emphasised the practice-based teams' involvement in the first stage of building a consumer survey. They often feel that the consumer survey findings are unhelpful for practical projects, as the consumer research questions are usually designed without an understanding of what engineers or designers need or want to know.

Furthermore, the interviewees spoke about insufficient time to read various kinds of data. According to them, they cannot muster the motivation to read data that are not potentially fully helpful for their actual work, since they are frequently under pressure to meet deadlines within a limited time.

Practice-based teams' opportunities for using internal data

From this validation study, three key suggestions were drawn from sample interviewees. Firstly, 88% of practice-based respondents from design and engineering teams agreed that the results of qualitative data from research teams need to be used as a reference for sharing and understanding different perspectives between research and practice divisions, rather than as requirements that designers or engineers have to meet (Kim, 2017). 50% of planning team respondents also stressed the importance of synthesising perspectives between research and practice divisions on consumer surveys. On the other hand, the other interviewees from the planning team agreed to the above methodology theoretically, but disagreed with it practically due to the time and human resources limit in MNEs. Secondly, 100% of the design and engineering teams pointed out that companies need to focus on how internal data actually help to stimulate the ideas of designers and engineers (quality), rather than how many times designers and engineers read internal data (quantity). For example:

> *"…Internal data can be likened to library. The library has many kinds of books for helping people get the useful information, not for making people to read all the books in the library. Therefore, libraries that do not have the books people want to read are pointless…"*
>
> *(Participant No. 2 in the design team)*

Thirdly, 83% of total respondents in the validation study agreed that problems were caused by the size of internal data and limited time to review it. Therefore, they suggested that it would be helpful when using data if a core range of information or guide for using data was offered as a reference.

To sum up, the following three factors might improve the level of using internal data when practice-based teams are generating and developing ideas: 1) using information from the planning team as a core reference for sharing a different perspective, not as a requirement; 2) establishing consumer data that embrace practice-based teams' opinions; 3) establishing a range of key information directly related to projects out of a vast amount of data.

4.3.5. Summary of Validation Study Findings

In the validation interview, most of the respondents from the three sample groups agreed to each result of the main interview questions. In addition, the reasons related to key issues were similar to the answers from the qualitative studies of the previous main interview. However, this validation study also discovered specific or in-depth findings in each sub-theme, as shown below.

A. Ideas and the Nature of Idea Generation Process

Confirmed

- Team's role and leadership style of a manager have a direct impact on the performance (positive and negative) of the idea generation activities
- A top-down structured approach appears to create mistrust between the planning and the design and engineering teams
- Diverse perspectives between the different teams on defining idea quality can contribute to disagreements and mistrust between the functions

Discovered

- Need for systematic management of rewards, time schedules, and human resources in idea generation stage

- Establishing a common language by synthesis of different perspectives on defining idea quality would potentially help increase employees’ confidence and reduce the level of uncertainty

The findings of the validation study aligned with those of the main study. In addition, they identified the need for systematic management at the idea generation stage of rewards, time schedule, and human resources. Furthermore, the results of the validation study showed that establishing a common language through a synthesis of different perspectives on defining idea quality can help increase employees’ confidence and reduce the level of uncertainty.

B. NPD Initiation and People’s Involvement

Confirmed

- Blended factors mainly related to consumer behaviour and needs, including emotional attraction, are key determinants of success or failure in developing new products in current markets
- A lack of communication and feedback exchange among diverse teams expands the gap between their perspectives on the information discovered, which leads to mistrust between the teams
- Mistrust reduces the overall contribution of the research team’s data and results to the development of new products
- The highest level of mistrust between diverse expert teams can specifically emerge from the different perspectives on consumer data, since consumer feedback appears to be a core element when building a product concept in current MNEs' NPD processes (e.g. implementing multiple consumer clinics across ES NPD to get consumer feedback)

Discovered

- New technologies have become a core factor that impacts consumers’ lifestyles and social trends
- The lack of efficient knowledge integration systems affects the employees’ motivations and also could bring uncertainty while generating and developing ideas

- More opportunities for successful NPD results might be obtained if multiple teams could provide a variety of ideas before the NPD concept is defined

In comparison to the main study, the validation study showed the impact of the new technology factor when initiating NPD as well as the consumer factor. In addition, the sample respondents in the validation study confirmed that different languages between different functional teams lead to emerging mistrust. Furthermore, they indicated that inefficient knowledge integration systems affect employees' motivation and uncertainty in generating and developing ideas, which can potentially lead to unsatisfactory NPD outcomes. In the validation study, the interviewees from the design and engineering teams mentioned the need for a space in the front-end phase where they can directly embed their insights into the NPD concept via use of their own perspectives or concept-sets. This finding showed that more opportunities for successful NPD results might be obtained if multiple teams could provide a variety of ideas before the NPD concept is defined.

C. Uncertainty in Idea Generation

Confirmed

- A team's role in NPD projects and its own perspectives on selecting and defining idea quality affects the levels of and reasons for uncertainty in the idea generation stage of NPD
- Understanding of other teams' different roles and perspectives in NPD can contribute to reducing mistrust and uncertainty in the idea generation stage

Discovered

- The low levels of involvement of practice-based teams in the idea generation stage inhibit establishing a common language between the three teams
- A synthesis of data elements from multiple sources for new opportunities has the potential to help to reduce uncertainty and achieve successful outcomes in current markets

The validation study confirmed that establishing a common language to understand different perspectives or roles in NPD reduces levels of mistrust and uncertainty while generating ideas. Specifically, it identified that sufficient communication channels between the planning and design/engineering teams help to build a common language, so that together they can synthesise disparate elements for new opportunities.

D. Data, Information and Insights (DII) that Stimulate Generating Ideas

Confirmed

- A team's role in the NPD process and its expertise are linked to the team's approach in how it uses data, information, and insights (DII)
- A lack of understanding of other teams' methods of using DII to generate ideas can lead to mistrust and can potentially create conflicts between teams
- Mistrust can result in a lack of effective use of a company's internal research data when developing new products
- The methods of using data to stimulate the creation of new ideas are different between each of the expert groups, and therefore the quality of synthesised ideas (i.e. ideas established by integration of each team's ideas) can potentially be improved if each expert group freely uses their preferred data and data use methods

Discovered

- Establishing consumer data that embraces practice-based teams' perspective and requirements (functional and emotional) could potentially reduce mistrust
- Providing a range of key information synthesised from a vast amount of data would potentially contribute to reducing uncertainty and motivating practice-based teams to use internal data more
- Combining individual autonomy with a company's systematic method of data use might be useful for obtaining high-quality insights

This validation study confirmed the gaps in each team's language – perspectives, requirements, and modes of seeking insights. Also, it has helped to identify that different languages between teams can affect the level of mistrust and use of internal data. In particular, the validation study discovered that the uncoordinated synthesis of different perspectives on consumer data significantly impacts on mistrust. Furthermore, an efficient data-collecting system, including a guide for utilising large amounts of data, would potentially be helpful to practice-based teams to reduce uncertainty and increase their motivation to use internal data. This research has also identified that combining individual autonomy with a company's systematic method of data use might be useful for obtaining high-quality insights.

4.4. Summary of Findings

Throughout the three stages of the empirical studies conducted in the study, interview results consistently indicated that a high level of importance is ascribed to the idea generation and development stage in NPD processes.

Also, the findings showed the significance of integration of diverse perspectives among different expert groups in the idea generation stage in order to improve quality of ideas and idea generation performance.

This section summarises each of the key findings of the three empirical components of the current study, namely (a) pilot study, (b) main study, and (c) validation study. A synthesis of the findings and related opportunities is also included in the section.

4.4.1. Summary of Key Findings

Pilot study

Four core issues were identified in the pilot study. Firstly, the idea generation and development stage (ES NPD) is regarded as a core part of MNEs' NPD. Secondly, the activities of research-based teams and practice-based teams in the idea generation stage differ significantly. Thirdly, the major transition point from research to practice occurs after the 'direction stage' (at GATE.3 of Cooper's NPD model, 1990; see Figure 17 on p.116). In other words, the main roles and levels of involvement for research and practice divisions change substantially after the NPD concept is fixed. Lastly, since planning, design, and engineering teams are invariably the main actors in idea generation and NPD in MNEs, interviews with all three functional teams would be helpful in aiding anticipation and investigation of critical issues.

Main study

The main study involved 34 participants, each of whom has at least five years' experience in either planning, design, and engineering departments in MNEs. The main study covered core issues relating to ideas, people, uncertainty, and data at the idea generation stage. The interviews confirmed huge differences in the level of involvement and the main activities that planning, design and engineering teams undertake in the early stages of NPD. This reinforced one of the key findings from the pilot study. In addition, the interview results identified the different perspectives and concept-sets (i.e. a series of approaches and perceptions when collecting and analysing data in order to acquire insights into the idea generation) that exist within the diverse functional teams whilst generating ideas.

Further, the findings indicated a lack of efficient systems, communication processes and a common language. All three factors can contribute to creating mutual mistrust and uncertainty between the research-based and practice-based teams.

Validation study

The validation interviews were undertaken with 12 respondents from the planning, design and engineering teams of MNEs in order to interrogate the main research results further and to attempt to confirm these. The outcome of this exercise was that most of the validation interview participants agreed with the results of the main study. This is useful as it reinforces confidence in the study's outcomes. Also, the interviews provided highly valuable additional information to contextualise, explain and underpin key findings.

In the validation interviews, elements that might reduce levels of mistrust and uncertainty were also discussed. This approach was taken in order to surface ideas that might lead to improved linkages between research and practice teams (for example, enhanced qualitative involvement of practice-based teams prior to freezing of NPD concepts, establishment of appropriate and sufficient feedback exchange channels, installation of equitable reward systems, and the creation of guidance for interrogation of large data sets and identification of vital data).

Emergent Findings linked to Focus, Direction and Development Stages

Focus Stage Findings:

At the focus stage, the mistrust and uncertainty are typically affected by 1) the lack of common language (different perspectives and concept-set), 2) inefficient system of multidisciplinary teams, and 3) the large size of internal information.

The lack of common language (different perspectives and concept-sets) at the focus stage creates mistrust, whilst trying to identify new market opportunities. The design and engineering teams expressed doubts about the planning team's subjective analysis and subsequent insights on new market opportunities. The multidisciplinary team activities run at the focus stage are undertaken mostly by temporary teams. However, the participants in the multidisciplinary teams showed a low level of motivation due to the lack of a proper reward system. Furthermore, the sample interviewees from design and engineering teams illustrated that they do not have enough time to read the huge amount of data delivered by research teams.

Direction Stage Findings:

In the direction stage, the mistrust and uncertainty are frequently affected by 1) the lack of common perspectives on the use of consumer data between different expert groups, 2) low level of involvement of practice-based teams (design and engineering teams) in the idea generation phase, and 3) top-down structured processes for building product concept.

Particularly, the sample interviewees revealed that the highest area of mistrust relates to the results of consumer data. The design and engineering teams pointed out that this mistrust is linked to the planning team's overreliance on numerical evidence and their generic insights, whereas the planning team is often concerned about the design team's overreliance on intuition when obtaining insights.

In addition, a top-down structured process in NPD appears to lead to the lack of feedback channels between teams and the low levels of involvement of practice-based teams in the idea generation phase. The low levels of involvement of the design and engineering teams in the idea generation phase appear to create more mistrust about the product concept. This appears to be because the design and engineering teams believe that they do not have a sufficient understanding of the context of how the product concept has been developed; also, they do not have opportunities to give their feedback about the main ideas established by the planning team and decision-makers.

Development Stage Findings:

Mistrust and uncertainty mainly impact on the application and use of the research results in the development of actual new products.

This study identified that the mistrust and uncertainty is linked to a perceived lack of usefulness of the internal data when developing actual products by the design and engineering teams. They revealed that they often have mistrust and disagree with the product concept and information delivered from the planning team; therefore, they often ignore internal data and, subsequently, collect new data themselves in ways that are familiar to themselves. This duplication of work in collecting data causes a waste of employees' working time and companies' budget. Ultimately, this creates difficulties regarding agreed research results, as the outcomes are often being generated and developed against differing agendas.

The following figures (Figures 18,19,20,21,22, and 23) have been developed in order to help visualise these emergent issues in relation to ES FEI NPD activities. The figures also indicate the level of involvement of each expert team within every activity of each stage.

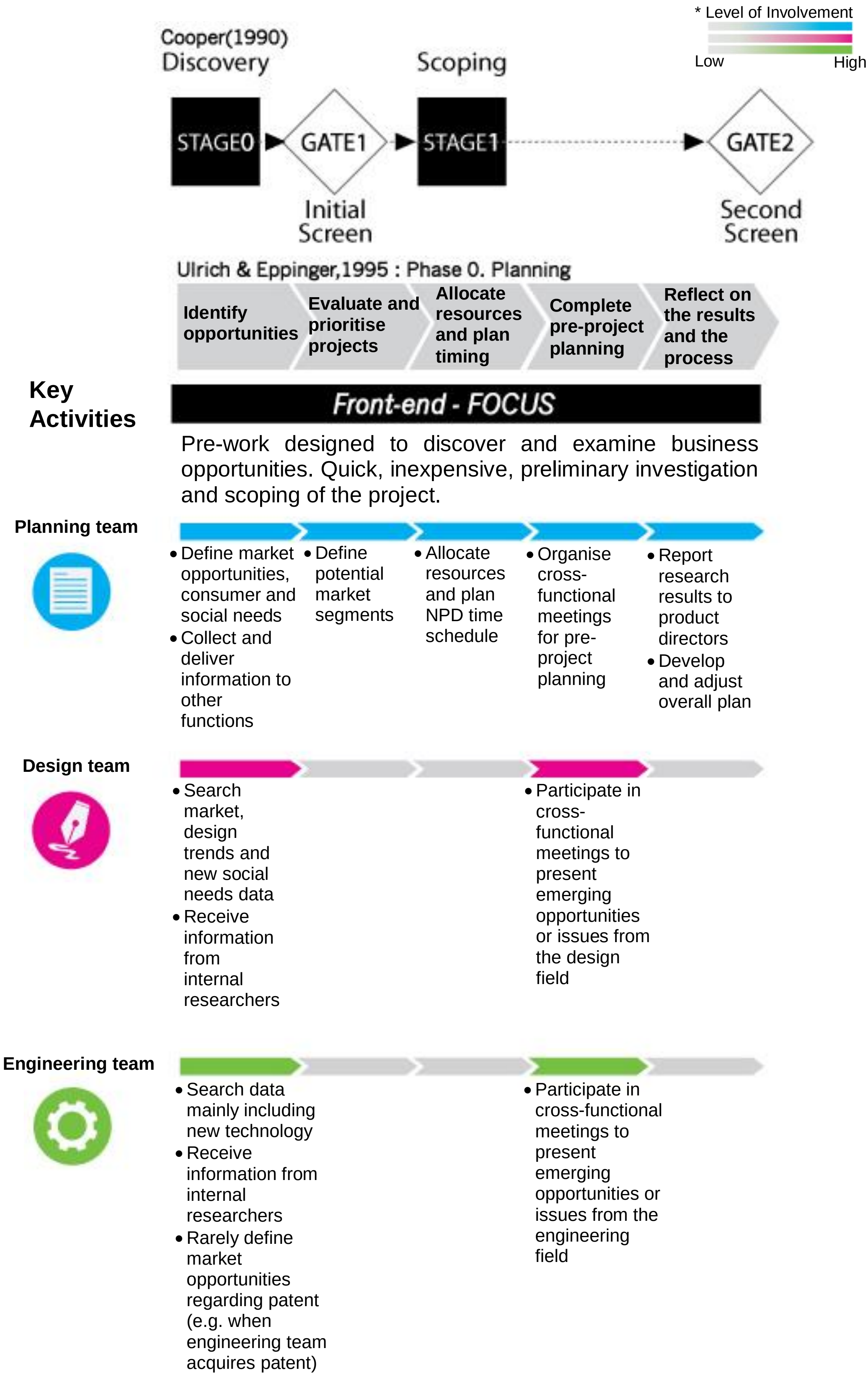


Figure 18. In-depth key activities of three functional teams – Focus stage

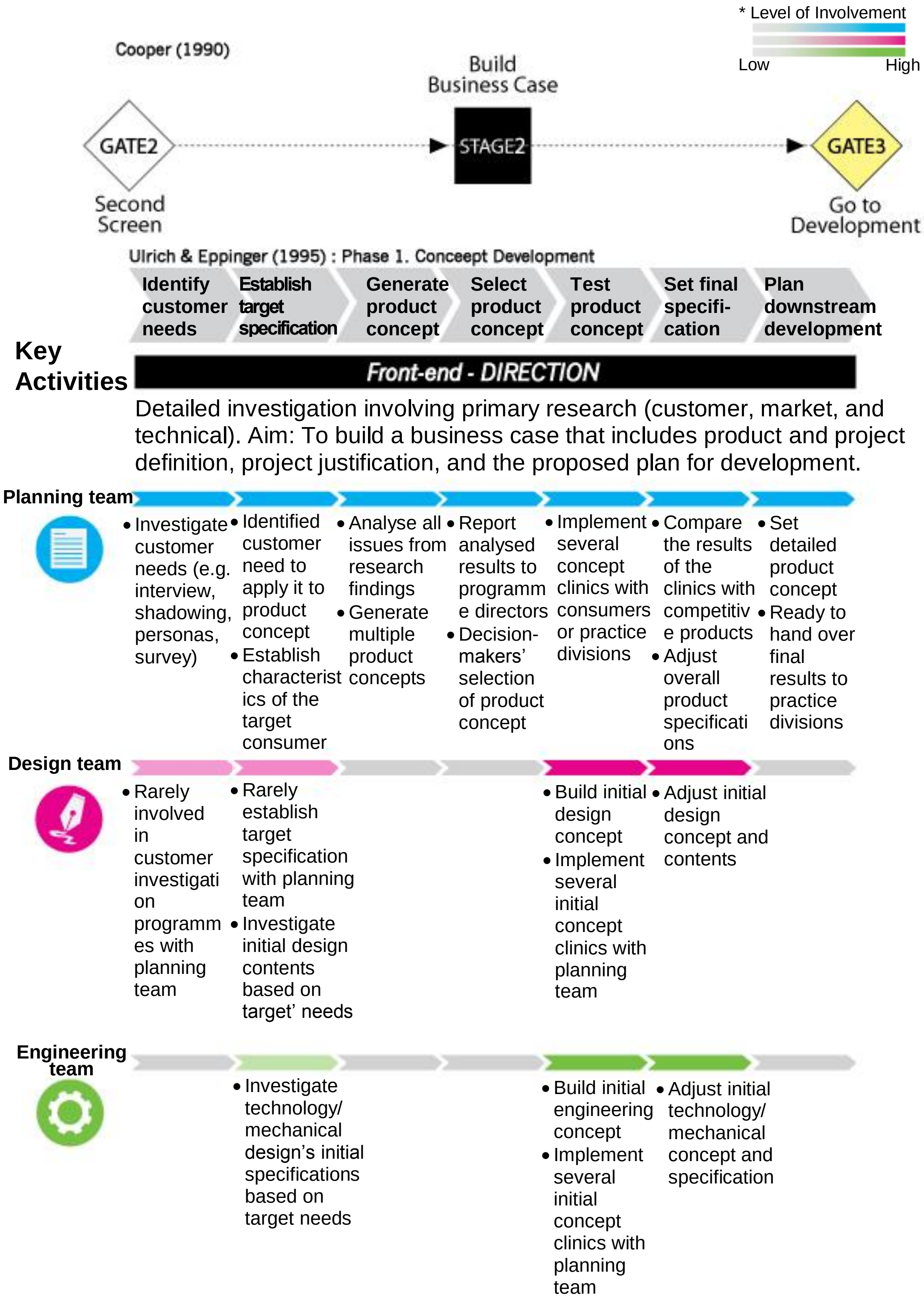
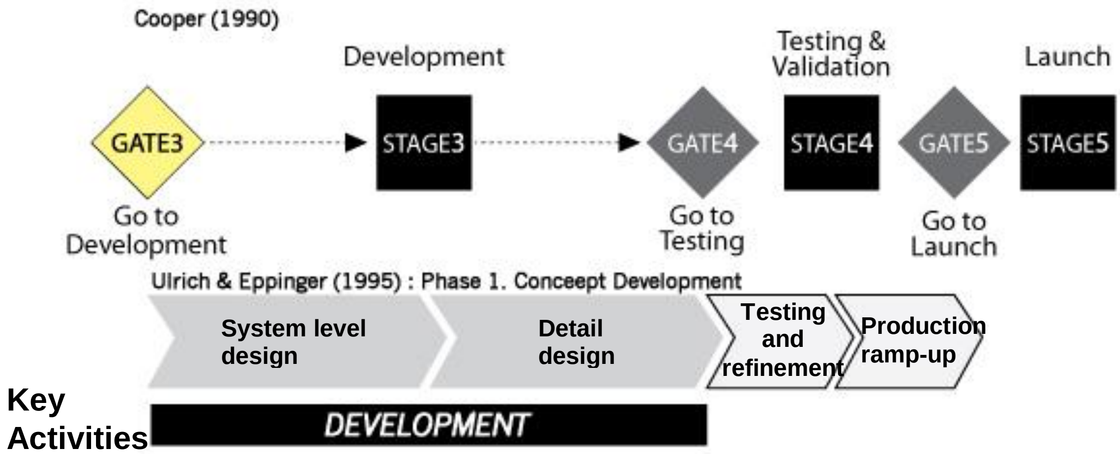


Figure 19. In-depth key activities of three functional teams – Direction stage



The actual detailed design and development of the new product including specification of geometry, materials, designing tools, planning cost effects.

Planning team

- Follow up on the project's progress
- Report to programme directors on emerging issues in developing products
- Adjust budget plan with engineering team
- Implement product clinics regularly, including customer surveys

- Follow up on the project's progress
- Report to programme directors on emerging issues in developing products
- Implement product clinics regularly, including customer surveys
- Develop a specific marketing plan

Design team

- Collect data and analyse it for development of actual products
- Set final design concept
- Create idea sketch
- Revise product's design specification based on the results of the product clinics
- Cooperate with engineering teams whenever design contents and concept are changed

- Create mock-up
- Revise mock-up based on the results of the product clinics
- Cooperate with engineering teams whenever design contents are changed
- Cooperate with suppliers for quality check of products

Engineering team

- Collect data and analyse it for development of actual products
- Set final assembly scheme and engineering concept
- Identify suppliers for key components
- Revise product's engineering specification based on the results of the product clinics
- Cooperate with design teams to check feasibility of the design contents

- Create mock-up
- Revise mock-up based on the results of the product clinics
- Cooperate with design teams to check feasibility of the design contents
- Cooperate with suppliers for development of moulds and product quality check
- Examine the financial, legal or environmental issues

* Level of Involvement
Low High

Figure 20. In-depth key activities of three functional teams – Development stage

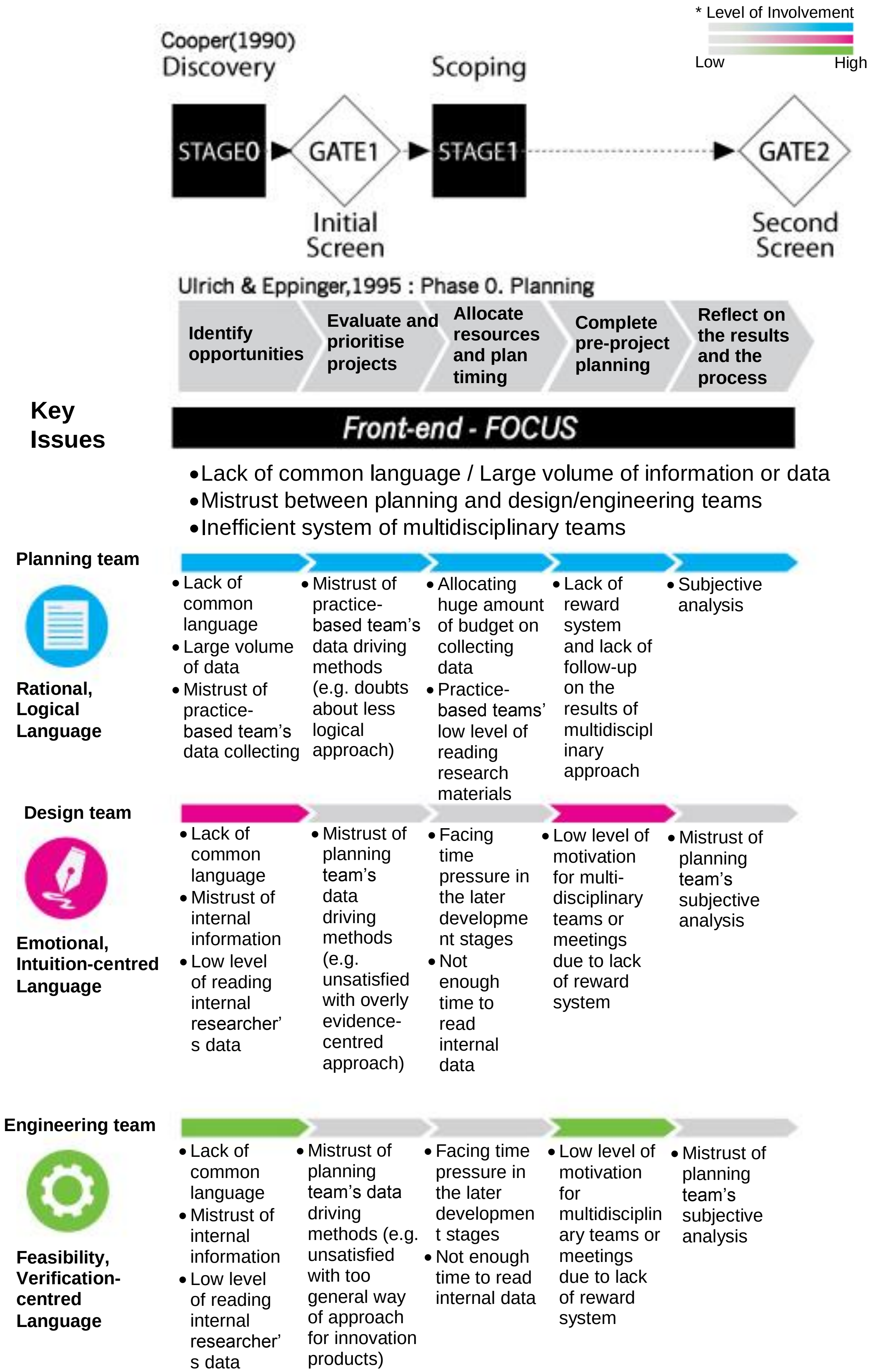


Figure 21. In-depth key issues – Focus stage

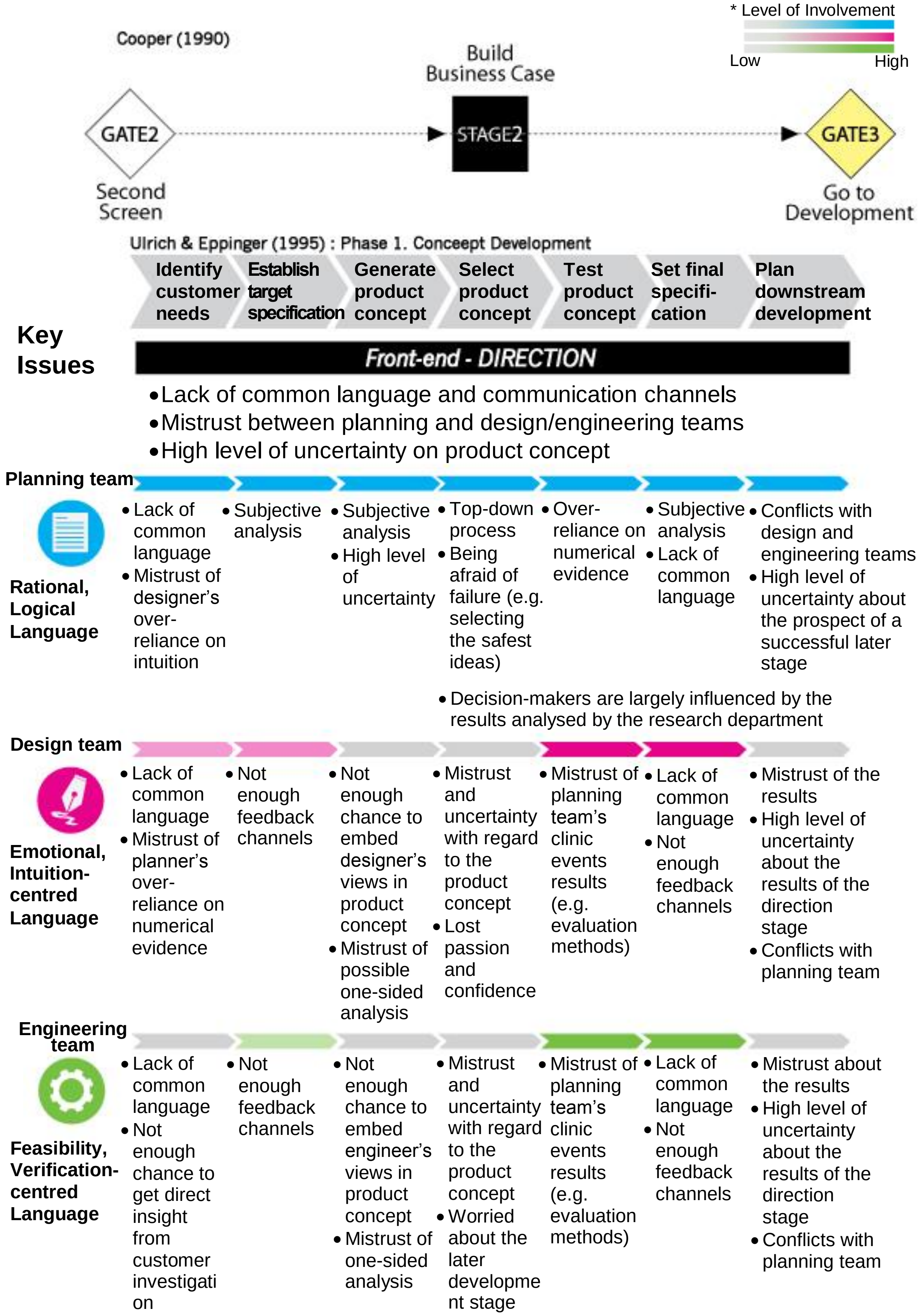


Figure 22. In-depth key issues – Direction stage

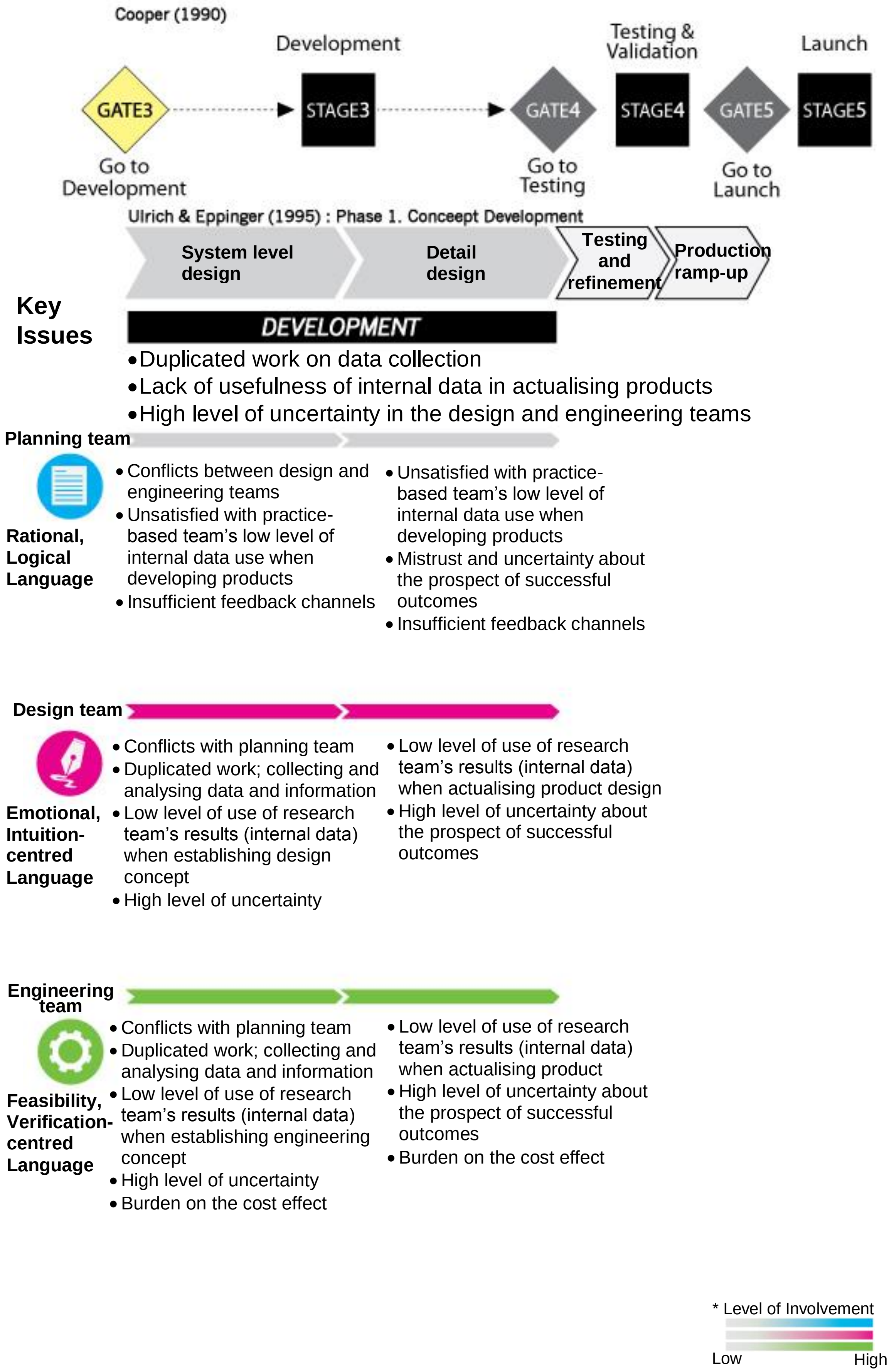


Figure 23. In-depth key issues – Development stage

4.4.2. Synthesis of Empirical Studies

In conclusion, this study identified five key points affecting difficulties in the linkage between research and practice in NPD:

- Lack of common language
- Lack of appropriate communication channels
- Lack of tactics for use in internal information
- Mistrust between research- and practice-based teams
- Uncertainty linked to lack of conviction in NPD context and quality of ideas

Lack of Common Language (mismatches in perspectives and concept-sets between each of the functional teams)

This study discovered that each functional group uses its own language (i.e. perspectives or concept-set) when generating ideas, and that there is a major difference between them. The planning team works primarily on the basis of numerical evidence and uses a rational and logic-centred approach. On the other hand, design teams generally develop ideas via a process of working with personal intuition and experience. In addition, designers indicate a notable interest in the pursuit of novelty. Engineering teams mainly deploy concepts and language that connect with feasibility and validity in the idea generation process.

The study also found that most idea generation activities in NPD are performed under circumstances in which the three types of teams do not sufficiently understand the language and roles used by their counterparts. This is a major driver for the emergence of mistrust and uncertainty. As a result, establishing a common language (or conceptual translation mechanism) is required as a means of integrating different languages.

Lack of Appropriate Communication Channels (Low level of involvement of practice-based teams in idea generation stage)

The empirical study identifies that there is a striking change in the roles and level of involvement of planning, design, and engineering teams for generating ideas after the direction stage (at GATE.3 of Cooper's NPD model, 1990, see Figure 17 on p.116). In particular, the study shows that the level of activities and responsibilities between the research-based team (planning) and practice-based team (design, engineer) are switched after GATE.3. In empirical studies, the low level of involvement of practice-based teams before GATE.3 was identified as a main factor that results in the poor translation of research results into actual practice. Design and engineering teams face difficulties in actualising NPD concepts generated from the insights of others, as they do not fully comprehend the context in which the concepts were derived. That is because the insufficient understanding of context and disagreement with other teams' insights (especially insights from consumer data) cause mistrust and uncertainty. Therefore, it is suggested that the level of involvement of practice-based teams should be improved before GATE 3.

For the improved involvement of practice divisions, there is a need for a space in which designers and engineers can generate ideas via use of their own perspectives or concept-sets before the transition point (GATE.3). In this way, various kinds of ideas can be embedded into the NPD concept.

In addition, the necessity for the establishment of appropriate feedback channels between research and practice teams is clear: it is important that perspectives can be shared and ideas developed in a collective way.

Lack of Efficient Tactics in Using Internal Information (inefficient system)

In both main and validation interviews, the excessive extent of internal data was continually highlighted as a problem. Large amounts of data are problematic where time pressure is in play. Also, the presence of large amounts of internal data reduces the motivation of workers (in the practice division) to read the data and it increases the level of uncertainty. Thus, the empirical study revealed a need for a structured system for effective use of the data delivered by the research division, for example providing a proper range of key information for assistance in navigating complex data sets.

The study also revealed a demand for appropriate rewards and feedback with respect to the performance of multidisciplinary teams. A majority of interview participants agreed that it is important to have a multidisciplinary team and cross-functional meetings in the idea generation process, as these permit the integration of varied knowledge bases and forms of expertise. However, the participants alluded to problems with its effectiveness, where multidisciplinary groups are lacking appropriate rewards and feedback systems. Many regarded the outcomes from multidisciplinary groups as sub-optimal as participants frequently fail to focus actively on idea generation tasks, and results are not effectively translated into real practice.

Mistrust between research- and practice-based teams

This study identified inefficient idea generation systems related to a lack of (1) a common language, (2) proper communication and feedback exchange, and (3) efficient tactics for using internal data in the front-end phase. These three factors could result in mistrust, especially between research- and practice-based teams. In particular, designers and engineers showed a high level of mistrust in the results of qualitative internal data related to consumer needs or behaviour. They both face difficulties in agreeing with outcomes analysed subjectively by the planning team, whose differing language is the main reason for diminished levels of internal data use. Also, the results of empirical studies indicated that this mistrust links to levels of uncertainty of employees when generating ideas.

Uncertainty (lack of conviction in NPD context and quality of ideas)

The findings of this study demonstrated that the level of uncertainty rises in proportion to the level of responsibility for work. Regarding this, this study discovered that the main reasons for a high level of uncertainty in practice-based teams in the development stage are their insufficient understanding of the NPD context and their mistrust of the results from the research-based team while they are attempting to actualise the NPD concept. For this reason, increasing practice-based teams' level of involvement in the front-end phase has been recommended, primarily as an opportunity to reduce uncertainty through integrating various perspectives into the NPD concept.

Furthermore, the synthesis of this study's findings has revealed that the following three implications can potentially arise due to this lack of effective cross-functional work in NPD: (i) misuse of internal data expertise, (ii) missed opportunities for improving quality of ideas and products, and (iii) missed market opportunities (see Figure 24).

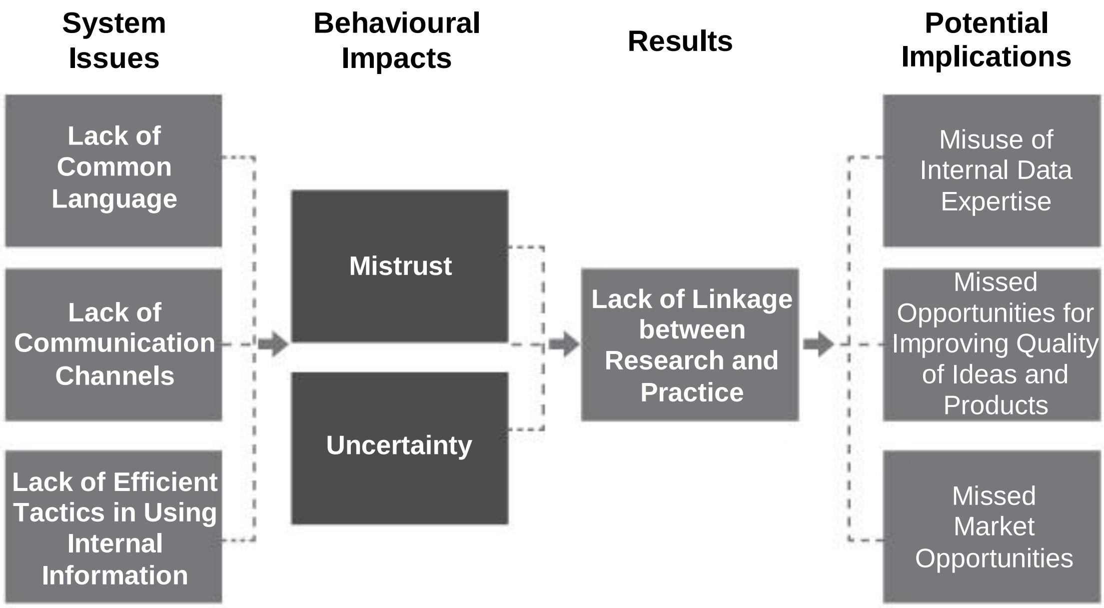


Figure 24. Synthesis of findings

4.4.3. Reflections on Findings

Difficulties between Research and Practice (Lack of Internal Data to Stimulate the Generation of Innovative Ideas)

Overall, this empirical study investigated the nature of recent MNEs' idea generation process in the front-end phase of NPD, and identified factors affecting problems in applying research results to practical works. Specifically, this study found that the problems and difficulties come from mistrust between different types of teams and uncertainties when generating ideas. Also, mistrust and uncertainty emerge from inefficient idea generation systems: lack of a common language, poor communication channels between different expertise teams, and inadequate tactics for using internal data.

Strategically, the main proposal of this study is to create a synthesis of various perspectives on idea quality by enabling practice-based teams to be involved qualitatively in the early parts of the idea generation phase. The resulting integrated language will reduce mistrust and uncertainty in the idea generation stage. Therefore, this study anticipates that minimising mistrust and uncertainty can contribute to internal data being used effectively to stimulate the creation of innovative ideas.

5. Discussion

Introduction

The main objective of this chapter is to analyse the comparison of the interview results of an empirical study with the issues emerging from the literature review in order to find opportunities to improve the front-end activities of NPD. In particular, this chapter provides a systematic review of the literature and of actual NPD activities in relation to each research question.

5.1. Responses to Research Questions

5.1.1. Research Question 1

What are the current nature of the idea generation processes and the importance of idea quality in ES of NPD processes?

To explore and answer the first research question, as regards ideas and idea quality, this study explored the following key areas:

- New Product Development (NPD) and Front End
- Idea Quality and Idea Quantity
- Systematic Idea Management
- Design Thinking
- Idea Quality Criteria

New Product Development (NPD) and Front End

This study identified that the groups in MNEs recognised the importance of the idea generation stage of NPD (Cooper, 1998; Craig & Hart, 1992). Rodgers et al. (1999) and Ulrich and Eppinger (2007) discussed the difficulties in meeting consumer needs in the indeterminate recent market, owing to fast-changing trends and the complicated environment deriving from mixed resources.

For this reason, the idea generation stage is addressed as a core part of the NPD process, as many key selections that might be attractive to future consumers are made during this period (Christensen et al., 2008; Cooper, 1997, 2001; Kim & Wilemon, 2007; Koen et al., 2001; Murphy & Kumar, 1997; Nobelius & Trygg, 2002). The results of the empirical study indicated that staff in MNEs are commonly aware that crucial decision-making is implemented in the front-end stage. In addition, most of the interviewees showed a high level of uncertainty when the main decision on NPD concept is made, since it affects the later stages of NPD (Bhamra, 2004; Cooper, 1988; MacMillan et al., 2001; Ölundh & Tingstrom, 2008) (see Table 77).

Topic: New Product Development (NPD) and Front End			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• The significance of the front end (idea generation) of NPD: many crucial decisions are made in this period	Cooper, 1998; Koen et al., 2001; Rodgers et al., 1999; Ulrich & Eppinger, 2007	• Agreement on the importance of the idea generation stage that is deeply related to achieving a successful business goal • High level of uncertainty due to the importance of the front-end stage	A.2 A.1 C.1 C.2
Conformance or contradiction between theoretical and empirical study: Conformance			
Insight: Recent market circumstances affect the level of importance of idea generation activities, which have an impact on high levels of uncertainty in the front-end phase.			
Key Words: NPD, Front End (Idea Generation Stage), Decision Making, Uncertainty			

Table 77. Summary of discussion of NPD and front end phase

Idea Quality and Quantity

In prior theoretical studies, the importance of idea quality and quantity was noted, and three perspectives were discovered. Osborn (1953) pointed out the importance of idea quantity, as he believed the quality of ideas is subordinate to their quantity (Gallupe et al., 1991; Shepherd et al., 1996). On the other hand, the researchers who supported the importance of idea quality (e.g. Björk & Magnusson, 2009; Fraser, 2009) illustrated that people consider how to obtain the high-quality ideas in order to make innovative products, because circumstances in business today are highly complicated (Cross, 2001; Hatchuel et al., 2010). Furthermore, Briggs et al. (2007) and Rietzschel et al. (2007) addressed a harmonised way of using both idea quantity and quality, and also referenced their equal chance to influence good ideas (blended approach). Regarding this literature review, the findings of the empirical study showed that people generally emphasised idea quality slightly more than idea quantity, but the gap between the two elements was small. It appears that people involved in actual NPD practice are aware of the importance of idea quality, but also of the effectiveness of synthesising the different methodologies when generating ideas (Björk & Magnusson, 2009) (see Table 78).

Topic: Idea Quality and Quantity			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Diverse views of idea quantity and quality in the idea studies: quantity-centred, quality-centred, equal probability • Importance of synthesis of different methodologies for high-quality ideas	Björk & Magnusson, 2009; Briggs et al., 2007; Osborn, 1953	• Common tendency to prioritise the quality of ideas for achieving innovative products • Consideration of integrating various methodologies to engender high-quality ideas	A.3
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Idea quality is the core element for successful NPD outcomes			
Key Words: Idea Quality, Idea Quantity, Synthesis of Methodology			

Table 78. Summary of discussion of idea quality and quantity

Systematic Idea Management

The most interesting finding in terms of managing idea generation was the need for a systematic process. The interview participants agreed on the necessity of improving the quality of existing idea generation processes, since the recent front-end process had limitations in obtaining valuable outcomes from a variety of expertise holders. This consideration for efficient systems for enhancing front-end results was also stated in many studies of idea generation (e.g. Bailey & Horvitz, 2010; Hubbard, 2010; Pugh, 1991; Sandström & Björk, 2010). LaValle et al. (2011) found that inefficient management can be an obstacle when companies generate new ideas, and the interview results also showed that inefficient knowledge integration activities and top-down structured processes in the front end creates high levels of mistrust and uncertainty. In addition, this study identified the need for flexibility in systematic idea management. The research results of Amabile (1998) showed that staff members' freedom and their clear comprehension of the goal are the essential ingredients for boosting their creativity in idea generation. Supporting this issue, interviewees from the design and engineering teams consistently stressed their need for the space to generate ideas using their own methods and insights (see Table 79).

<table>
<tr><td colspan="4">Topic. Systematic Idea Management</td></tr>
<tr><th colspan="2">Theoretical Study</th><th colspan="2">Empirical Study</th></tr>
<tr><th>Key Findings</th><th>Literature</th><th>Key Findings</th><th>Interviews</th></tr>
<tr><td>• Necessity for systematic management of idea generation to reduce uncertainty
• Importance of flexibility when developing effective management system</td><td>Amabile, 1998; Hubbard, 2010; LaValle et al., 2011; Pugh, 1991</td><td>• Need for a well-structured system to reduce mistrust and uncertainty
• Necessity for practice-based team to have the chance to use their own method and perspectives while creating ideas</td><td>A.4
B.2
C.1
D.1</td></tr>
<tr><td colspan="4">Conformance or contradiction between theoretical and empirical studies: Conformance</td></tr>
<tr><td colspan="4">Insight: Systematic idea management is vital for generating high-quality ideas, and presenting appropriate freedom to staff members is the key tactic for systematic idea management in order to reduce mistrust and uncertainty.</td></tr>
<tr><td colspan="4">Key Words: Efficient System, Idea Quality, Flexibility, Mistrust, Uncertainty</td></tr>
</table>

Table 79. Summary of discussion of systematic idea management

Design Thinking

In the literature review, a number of studies illustrated that applying the blended thinking of opposite perspectives (such as conventional and explorative thinking or rational and emotional thinking) might spark innovative ideas to deal with unpredictable or complicated consumer needs in our recent fast-changing environment, which is called design thinking (Brown, 2008; Lockwood, 2010; Martin, 2010; Pink, 2006). This study identified that most of the interviewees from three functional teams recognised the importance of blended ideas; however, they showed a high level of doubt as to the real effectiveness of multidisciplinary or cross-functional approaches in recent NPD processes due to inefficiency in involving people and in feedback systems. Also, contrary to the concerns in the literature that many companies still tend to rely on conventional methods (Campbell et al., 2009; Martin, 2009; Pink, 2006; Schon, 1983; Williams, 2010), the findings of the empirical research showed that many are making an effort to adopt new methodologies to integrate various kinds of knowledge (e.g. cross-functional meetings, staff exchange, internal expert groups who focus on innovation tools, staff idea competitions). Brown (2008) emphasised a human-centred approach through design thinking, since physical function alone is not attractive enough to prompt customers to purchase products in the current market, in which many of the same functional products are competing (Pink, 2006). In a similar vein, the interviewees discussed the importance of the design team on idea generation, because their main role is to meet both consumer benefit and successful actual practice via their emotional intuition (see Table 80).

Topic. Design Thinking			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Advantages of mixing opposing ideas • Concerns about many companies holding on to existing methodologies in idea generation	Brown, 2008; Campbell et al., 2009; Martin, 2010; Pink, 2006	• Agreement on the importance of integrating different types of ideas • Doubt about the effectiveness of existing system • Companies making efforts to find new methods of integrating various kinds of ideas • Meaning of design team's role in recent market circumstances	A.4 B.2 A.5
Conformance or contradiction between theoretical and empirical studies: Part Conformance			
Insight: Design thinking is regarded as an important factor for achieving success in the current market. To reduce mistrust, companies need to revise their existing system of involving people and their multidisciplinary approach.			
Key Words: Combination of opposite characteristics, People Involvement, Mistrust, Inefficient System			

Table 80. Summary of discussion of design thinking

Idea Quality Criteria

A number of idea generation studies have conducted investigations into evaluating idea quality (Gressgård, 2012), since NPD's basic attribute is a knowledge-based activity (Lawson et al., 2009). In addition, they state that a quality-focused methodology may enrich idea generation results (Briggs & Reinig, 2010). Selart et al. (2011) illustrated that idea-quality criteria are usually built based on recent market circumstances. From a literature review, this study identified the following factors as the core criteria of evaluating idea quality: originality and novelty (e.g. Hart et al., 2003; Reinig & Briggs, 2008); feasibility (e.g. Hart et al., 2003; Kramer & Kuo, 1997); business objective (e.g. Brem, 2011); capability (e.g. Faure, 2004; Ozer, 2005); market potential values (e.g. Björk & Magnusson, 2009; Chesbrough, 2004; Hart et al., 2003); consumer benefit (e.g. Reinig et al., 2007; Wirtz, 2003); and gut feeling (e.g. Eling, 2014; Hart et al., 2003).

The findings from the empirical study revealed that people generally prefer idea quality criteria related to their main role in NPD. Also, the findings discovered that decision-makers' perspectives of business objectives significantly affect actual assessment of idea quality; therefore, employees often mistrust the results of idea quality evaluation.

Furthermore, the interview respondents stated that the most effective way of evaluating idea quality is by using a common language arrived at by a synthesis of different perspectives from various experts. These opinions are shared by Negroponte (2003) and Björk and Magnusson (2009), i.e., mixing knowledge from a wide spectrum of experiences can bring high-quality ideas (see Table 81).

Topic. Idea Quality Criteria			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Variability of idea-quality criteria affected by recent market circumstance • Advantage of mixing perspectives from a variety of experiences in the assessment of idea quality	Björk and Magnusson, 2009; Briggs & Reinig, 2010; Gressgård, 2012; Negroponte, 2003; Selart et al., 2011	• Different perspectives of defining idea quality among different teams • The need for a common language, including views of various fields, to effectively evaluate the quality of ideas and obtain valuable results	A.5 C.2
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Establishing a common language on evaluating idea quality can reduce mistrust of selected ideas and bring valuable results.			
Key Words: Idea Quality, Common Language, Mistrust			

Table 81. Summary of discussion of idea-quality criteria

Through the exploration of the research question regarding ideas and idea quality, several key insights related to a potentially effective idea generation system were revealed.

Currently, MNEs are required to provide products that satisfy the functional and emotional needs of consumers; therefore, idea generation through design thinking is regarded as a core element of a company's NPD processes within the market environment. In order to meld this design thinking into companies' NPD processes, it is important that various expert groups participate in the idea generation stage to ensure integration of diverse ideas.

This study identified that all the sample companies, which are currently leading their market, still have difficulties in establishing systematic idea generation processes and that there is conflict between the different functional teams. The synthesised insights of this study showed that, in order to generate successful and high-quality ideas in the idea generation stage, there is a need to reduce mistrust between different expert groups. This can be accomplished by establishing a common language and an effective idea generation system that helps to maximise the efficiency of integrating different perspectives.

5.1.2. Research Question 2

What are the reasons for initiating new projects, and what is the nature and level of involvement of various functional groups in the idea generation phase?

To explore and answer the second research question, as regards project initiation and people's involvement, this study explored the following key areas:

- Uncertain Business Environment
- Knowledge Sharing and Multidisciplinary Thinking
- Integrating Different Types of Expertise
- Disconnection between Research and Practice
- Employee's Involvement

Uncertain Business Environment

In NPD studies, uncertainty is usually defined as the atmosphere in which it is difficult to reflect unpredictable market change quickly (MacCormack, Verganti, & Lansiti, 2001; Ries, 2011; Spender, 1993). To cope with this uncertain environment, companies are asked to develop unique strategic tactics when generating ideas (Ledwith et al., 2006; Pink, 2006), which affects the basis of today's market competition (Hagel, Seely Brown, & Davison, 2008; Hamel & Prahalad, 1991). From this empirical study, current sample companies indicated their efforts towards finding new methods for idea generation within an uncertain business environment.

However, they also expressed difficulties establishing unique and efficient methodologies. Furthermore, most of the sample interviewees commonly considered consumer needs and new social trends and behaviour as the most important reasons for starting NPD. This is because consumer needs have become more complicated within uncertain environments, while dealing with their feedback has become a key challenge for forecasting success in the market (Brown & Eisenhardt, 1995; Cooper & Kleinschmidt, 1987). In addition, the validation study showed that new technology is becoming one of the core factors affecting consumers' lifestyle and social trends (see Table 82).

Topic. Uncertain Business Environment			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Importance of ability to react to complicated consumer needs within recent uncertain and fast-changing market environment • Need for unique strategic tactics for generating ideas	Brown et al., 1995; Hagel et al., 2008; Ledwith et al., 2006	• Many companies' efforts to meet consumer needs • The importance of the data related to consumer behaviour and needs when starting NPD • Technology factor affects consumers' lifestyle and social trends	B.1 A.4 C.1
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Establishing strategic tactics is one of the key elements for translating consumer needs into the results of successful NPD in the recent uncertain market.			
Key Words: Consumer Needs, Uncertainty, Strategic Tactics			

Table 82. Summary of discussion of uncertain business environment

Knowledge Sharing and Multidisciplinary Thinking

A number of studies emphasised the need for appropriate knowledge-sharing processes that help create synthesised, breakthrough ideas (e.g. Holloway, 2009; Lawson et al., 2009; Negroponte, 2003; Warren & Fuller, 2009;). For this reason, multidisciplinary teams or cross-functional tasks were mentioned as key solutions for facilitating effective knowledge sharing and synthesising different ideas (Jansen et al., 1995; Nissani, 1997).

However, this empirical study showed contradictory results. The sample groups were aware of the importance of the multidisciplinary teams and activities in NPD, but they had doubts about the effectiveness of the multidisciplinary approach for creating high-quality synthesised ideas. Also, the interview results revealed that the mistrust of the multidisciplinary approach in recent idea generation processes usually comes from inappropriate reward and feedback systems. Companies realised the necessity of a multidisciplinary approach for sharing and synthesising ideas, but they still face difficulties in finding effective ways to do so (Lawson et al., 2009) (see Table 83).

Topic. Knowledge Sharing and Multidisciplinary Thinking			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• The necessity of a proper knowledge-sharing process to generate high-quality blended ideas • The needs for multidisciplinary teams or a cross-functional approach for blending various ideas	Holloway, 2009; Lawson et al., 2009; Negroponte, 2003; Warren & Fuller, 2009	• Common recognition across companies about the importance of multidisciplinary teams • Doubts about the effectiveness of multidisciplinary teams due to their low-quality results caused by lack of reward and feedback system	B.2 A.4 C.3
Conformance or contradiction between theoretical and empirical studies: Contradiction			
Insight: Unlike the result of the literature review, a multidisciplinary team is not helpful for sharing or synthesising multiple kinds of knowledge in actual practice. A proper reward and feedback system is needed for improving the effectiveness of multidisciplinary teams.			
Key Words: Multidisciplinary Team, Synthesised Ideas, Knowledge Sharing, Mistrust, Reward And Feedback System			

Table 83. Summary of discussion of knowledge sharing and multidisciplinary thinking

Integrating Different Types of Expertise

Generally, multiple studies of integrating different types of expertise have stated the various angles of observation and judgement on product quality and consumer needs as the main advantage of the synthesised ideas (Vissers et al., 2002). Also, multiple researchers have investigated methods of improving the existing NPD system to enhance the performance of the interdepartmental integration (e.g. Cooper & Edgett, 2006; Trott, 2012; Ulrich & Eppinger, 2007).

Regarding the literature review, the empirical study found that employees still have a high level of mistrust and uncertainty in recent idea generation systems, despite the great effort of companies to develop knowledge integration systems. The interview results also demonstrated that the mistrust mainly comes from the low level of involvement of practice-based teams in the front-end phase, which causes insufficient chances to integrate different perspectives when building product concepts. On the other hand, some researchers have been concerned about information overload as a side effect of the integration of various knowledge areas (Olson, Walker, & Ruckert 1995). In this regard, 40% of the main interview respondents on planning teams said that considering an efficient system is a priority before engaging a variety types of teams in the early stages of NPD, since MNEs have a practical limitation in using human resources, due to the size of the groups (see Table 84).

Topic. Integrating Different Types of Expertise			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Importance of efficient system for integrating different expertise to enrich idea quality • Concerns about information overload	Buchanan, 2001; Cooper & Edgett, 2006; Hubbard, 2010; Vissers et al., 2002	• Emerging mistrust due to the lack of chances to integrate different perspectives when building product concept • Needs for effective system that covers the limits of using human resources within large organisations	B.2 A.4 A.5 C.2
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Increasing the level of involvement of practice-based teams within a proper human resource system in the front-end stage contributes to improving the quality of integrated ideas			
Key Words: Idea Quality, Synthesised Ideas, People's Involvement, Mistrust, Uncertainty			

Table 84. Summary of Discussion of Integrating Different Types of Teams

Disconnection between Research and Practice

The difficulties of applying research results to actual practice have been discussed in a number of NPD studies (e.g. Buchanan, 2001; Cross, 2001; Gregor et al., 2007). Pugh (1991) and Hubbard (2010) addressed the disconnection between research and practice that might emerge from a lack of appropriate systematic methodology. In this empirical study outcome, the insufficient communication channels between research- and practice-based teams were shown as the main reasons for the disconnection. Even though the demand for an efficient feedback channel between the two divisions continues, MNEs are still engaging only limited teams and employees in the idea creation phase (Vissers et al., 2002).

As a result, during idea creation for practical works, the practice-based teams indicated a low level of using internal data delivered by research-based teams. That is because the practice-based teams hesitate to adopt others' insights without understanding the context of the research results (see Table 85).

Topic. Disconnection between Research and Practice			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Disconnection between research and practice in NPD • Involvement of limited employees in early part of NPD	Buchanan, 2001; Cross, 2001; Hubbard. 2010; Pugh, 1991	• Insufficient feedback exchange channels between research and practice teams • Low level of using internal data delivered from research team	B.2 D.5
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: The level of involvement and feedback of practice-based teams in front-end phase affects the level of usage of research results when they develop actual practice			
Key Words: People Involvement, Communication Channels, Stimulus Data			

Table 85. Summary of discussion of disconnection between research and practice

Employee Involvement

Many scholars have argued that collaborative work among different kinds of teams in the early part of NPD could enable people to trust each other (Souder, 1987) and lead to achieving business goals (e.g. Griffin et al., 1992, 1996; Parry et al., 1993), since NPD processes are basically performed for coping with issues emerging from various fields (Ruekert et al., 1987; Song et al., 1998). Also, minimising uncertainty among staff in the early stage entails fewer risks and more opportunities for innovation (Moenaert et al., 1995; Rochford,1991).

The findings from this empirical study were consistent with this point of view from the literature. Most of the interviewees noted feeling high levels of uncertainty, especially when having the responsibility of leading projects（Dougherty,1992; Souder et al., 1993), since they mistrust the results handed in from other departments. Also, they stated the importance of the direction stage as well as its high level of uncertainty. The interviewees are acutely aware that adjusting problems after deciding on an NPD concept is difficult, and it affects the later stages. The interview outcomes showed that this mistrust and uncertainty mainly emerges from a lack of appropriated involvement of the practice-based teams when generating main ideas. Furthermore, some of the studies demonstrated that employees' psychological ownership of a project by a high level of engagement is related to their strong motivation for cooperative performance (e.g. Abrashoff, 2007; Rubenfeld, & Morgan, 1991). Similarly, most of the interviewees showed a strong desire only for the stage in which they are deeply involved. Also, many interviewees were continually concerned about the low level of motivation in the multidisciplinary approach, due to the lack of reward and feedback related to their personal ownership (see Table 86).

Topic. Employee Involvement			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Need of employees' appropriate level of engagement for high-quality cooperation works	Abrashoff, 2007; Rochford,1991; Song et al., 1998; Souder, 1987	• Correlation between level of the uncertainty and mistrust and level of people's involvement • Correlation between level of motivation and level of people's involvement	B.2 C.1 A.2
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Employees' appropriate level of engagement for generating ideas has an effect on reducing mistrust and uncertainty and increasing their motivation, which impacts the success of achieving NPD goal			
Key Words: People's Involvement, Mistrust, Uncertainty, Ownership, Cooperation			

Table 86. Summary of discussion of employee's involvement

Several key insights related to potentially effective idea integration activities have been revealed through the exploration of project initiation and people's involvement in the idea generation process.

In conclusion, this study found that NPD processes require strategic tactics for synthesising ideas from diverse expertise holders, as the characteristics of today's consumers and markets are complex and unpredictable. Increasing the level of practice-based teams' involvement and boosting the communication channels between various functional teams during the idea generation phase can achieve this goal. The increased communication can reduce mistrust and uncertainty between the planning and design/engineering teams, which will augment the design and engineering teams' level of using the internal data provided by the planning team. In addition, a proper reward and feedback system could contribute to improving the effectiveness of multidisciplinary teams.

In summary, this study has gained insights into the relationship between an appropriate level of engagement for generating ideas and reducing mistrust and uncertainty and increasing employees' motivation, which impacts on the potential of achieving NPD goals.

5.1.3. Research Question 3

What are the factors that affect uncertainty when generating and developing new ideas?

To explore and answer the third research question, as regards uncertainty in idea generation, this study explored the following key areas:

- Internal Conflicts and Their Effects
- From Data to Insight
- Learning from Failure or Changing Plans
- Pattern Recognition – Looking at the Big Picture

Internal Conflicts and Their Effects

Although NPD is basically completed by cooperative work among multiple staff (Xie & Song et al., 1998), this work often brings internal conflict between teams due to variations in thinking, language, and work journeys (Lam & Chin, 2005). According to Rahim (1986), this internal conflict has both pros and cons; critical arguments between different types of experts might be helpful for stimulating innovation, creativity, and better decision-making, while dissatisfaction, mistrust, and difficulties in relationships can emerge at the same time.

The result of the empirical study demonstrated that research- and practice-based teams often face internal conflict in idea generation phases, owing to high levels of mistrust caused by differing perspectives on ideas and insufficient understanding of the roles and views of the other team. Also, the study found that staff had few opportunities to exchange critical feedback with each other in recent processes. Furthermore, the staff felt that there were insufficient chances for exchanging feedback, leading to the design and engineering teams experiencing a high level of uncertainty whilst developing actual products.

They suggested that they lacked sufficient understanding of the context of the research results delivered from the research-based team (Pelled & Adler, 1994) (see Table 87).

Topic. Internal Conflicts and Their Effects			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Conflicts between different teams within one organisation due to different languages • Pros and cons of internal conflicts: critical views on different opinions or mistrust • Correlation between level of understanding of project context and level of internal conflict	Pelled & Adler, 1994; Rahim, 1986; Xie & Song et al., 1998	• Conflicts between research teams and practice teams due to language differences • Lack of proper channels to exchange various critical views • High level of uncertainty in idea generation stage owing to insufficient understanding of other teams' roles and perspectives	C.1 C.2 C.3 B.2
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: The gap in languages and the lack of channels to share divergent opinions are major factors of mistrust and uncertainty			
Key Words: Different Language, Lack of Feedback Channels, Mistrust, Internal Conflict			

Table 87. Summary of Discussion of Internal Conflicts and Their Effects

From Data to Insight

Lycett (2013) explained that, although today's software can help to extract key meaning from a large amount of information (Davenport & Harris, 2007; Sharma et al., 2010), defining value in the results still requires human insight. One of the main findings from the empirical study is that practice-based teams do not want to apply the research-based team's analysis and results to their practice. This disinclination is due to the different ways of defining and decoding insights between planning and practice-based teams.

In addition, the empirical study's results demonstrated that the lack of appropriate communication channels between research and practice divisions is one of the factors affecting problems in applying insight from the research results to real practice.

Shanks et al. (2011) argued that, in an environment of conflict without cooperation between two opposite units, it is hard to convert insights into business value (see Table 88).

Topic. Data to Insight			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• The importance of human insight when developing ideas • Difficulties in NPD caused by uncooperative working environments	Lycett, 2013; Shanks et al., 2011; Verganti, 2009	• Disinclination to adopt insights analysed by other teams • The main reason for reluctance in using internal materials: lack of proper communication between other functional teams	C.2 D.5 A.5 B.2
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Insights obtained by blended perspectives (common language) can be used efficiently in NPD			
Key Words: Lack of Communication Channels, Different Insights, Internal Data, Mistrust			

Table 88. Summary of discussion of from data to insights

Learning from failure or Changing Plan

In today's fast-changing environment, it is doubtful whether the continuance of even robust plans from the early stages of a business can form the basis for future business success (Cross, 2001; Hatchuel et al., 2010; Ries, 2011). Therefore, many studies related to NPD pivot points have viewed the changing plans not as a failure, but as another route for achieving successful outcomes of a project (e.g. Majaro,1991; Ries, 2011; Scott et al., 2000). In addition, encouraging employees not to be afraid of new challenges or failures is also suggested for maximising the creativity of new ideas (Amabile, 1988; Sethi et al., 2001).

In contrast to the theories, many MNEs deny employees the opportunity to change plans in the early part of actual NPD practice. This is because the practice-based teams do not have sufficient channels in the early stages of NPD to give feedback about the product concept to the planning team for adjusting a plan. The ideas and insights obtained by the planning team's subjective interpretation of data have low chances of being checked by various perspectives, or of having meaningful changes made to them. Also, because of fears about risking time and money by changing the concept or direction after an early stage of NPD, design and engineering teams hesitate to ask for product concept revisions in the development stage. As a result, these teams begin to develop products that differ from their own perspectives, while harbouring a high level of mistrust and uncertainty (see Table 89).

Topic. Learning from Failure or Changing Plan			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Mind-set to regard failure and plan change as a new opportunity for future success of business • A company atmosphere that challenges employees to develop new ideas without fearing failure	Bonabeau et al., 2008; Cross, 2001; Ries, 2011; Sethi et al., 2001	• Inefficient NPD system leading to difficulties in changing plans in idea generation phase • Difficulties in creating innovative employee ideas due to the company culture that fears risking time and money	C.2 C.3 B.2 A.4
Conformance or contradiction between theoretical and empirical studies: Contradiction			
Insight: More opportunities for successful NPD results might be obtained if multiple teams could provide a variety of ideas before the NPD concept is defined.			
Key Words: Inefficient System, People's Involvement, Change Plan, Opportunity			

Table 89. Summary of discussion of learning from failure or changing plan

Pattern Recognition – Seeing the Big Picture

Pink (2006) has argued that it is an important requirement to combine different notions across boundaries in order to develop the ability to see the bigger picture (i.e. pattern recognition).

This is because problems in our recent uncertain environment often come from unexpected sources (Sarasvathy, 2001; Williams, 2010). In addition, studies addressing the importance of the big picture have illustrated that, to achieve exceptional results in NPD processes, all employees in an organisation must understand the big picture of the project and recognise its patterns, since NPD is performed in complex environments by people with a wide range of knowledge (Lawson et al., 2009; Pink, 2006; Warren & Fuller, 2009).

In this connection, most of the interviewees from the empirical study noted the importance of employees' ability to see the bigger picture. However, this study identified that the practice-based team has few chances to acquire information for seeing the big picture, even though they realise that comprehending the NPD context is helpful in developing their ideas. Furthermore, not understanding the context of the product concept (how and why the product concept is developed or evolved) often results in mistrust and uncertainty on the part of the design and engineering teams (see Table 90).

Topic. Pattern Recognition – Seeing the Big Picture			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Importance of recognising patterns within uncertain market environment • Need for all employees to see a big picture of the whole project	Lawson et al., 2009; Pink, 2006; Sarasvathy, 2001; Warren & Fuller, 2009	• Agreement on the importance of all employees seeing the big picture • Lack of efficient system for enabling practice-based team to see a big picture • Impacts of level of pattern recognition on the level of mistrust and uncertainty	C.2 B.2
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Providing all employees with the opportunity to see the bigger picture of the whole project might contribute to reducing mistrust and uncertainty during NPD journey			
Key Words: People's Involvement, Pattern Recognition, Uncertainty			

Table 90. Summary of discussion of pattern recognition – seeing the big picture

Through the exploration of uncertainty in idea generation, several key insights related to reducing uncertainty in cross-functional performances in ES NPD activities have been investigated.

Both the literature and empirical studies indicate that, to reduce mistrust and uncertainty, it is necessary for employees to understand the big picture of the entire project (understanding context of the product concept), in order for them to be able to create various alternatives and ideas within a cooperative working environment. To do this, appropriate communication between different functional teams is needed. For example, this would improve the defining of the NPD concept, enabling employees to better understand other teams' perspectives and roles and potentially build a common language. There are potentially more opportunities to reduce uncertainty of product concept and gain successful NPD results if sufficient communication between teams is achieved before the NPD concept is defined; this is because multiple teams can provide a variety of ideas that help to improve the quality of the product concept.

5.1.4. Research Question 4

What data types, resources, and formats are typically used in stimulating or generating new ideas?

To explore and answer the fourth research question, as regards data, information and insights that stimulate ideas, this study explored the following key areas:

- Difficulties in Accurate Information Selection (Internet Environment and Reliability)
- Different Language and Mistrust
- Stimulus Data (Use of Data: Content, Resources, Format)
- Mistrust of Qualitative Data
- Complexity to Simplicity of Information

Difficulties in Accurate Information Selection

It appeared that the collection of data for idea generation usually relies on the information from web search engines, with the internet environment enabling people to use the data that they perceive they want, irrespective of time and space (Tanenbaum, 2003). However, a tremendous amount of data on the internet is unreliable information. It has been suggested that the vast amount of data exceeds a human's cognitive ability to use and to select data accurately (Ginchereau et al., 1997; Memmi, 2014), which might result in misjudgement from the overload (Eppler & Mengis, 2004). Björk and Ottosson (2008) also stated that this open source internet allows competitors to acquire the same information.

Therefore, a number of studies recommended that companies need more sophisticated, customised and intelligent data-filtering methods in order to select valuable and distinguishing information (e.g. Hatchuel et al., 2010; Kumar, 2012; Kusiak & Tang, 2006; Schon, 1983). This empirical study identified that most of the sample MNEs usually leave data collecting and selecting to the individual's own methods and subjective judgement, and many interviewees often used data from web search engines to collect information. Also, this empirical study identified that the sample companies' research teams send a large amount of information to each team every quarter. In this regard, empirical research has found that the sample MNEs' employees want a systematic guide for the use of a large amount of data (see Table 91).

<table>
<tr><th colspan="4">Topic. Difficulties in Accurate Information Selection</th></tr>
<tr><th colspan="2">Theoretical Study</th><th colspan="2">Empirical Study</th></tr>
<tr><th>Key Findings</th><th>Literature</th><th>Key Findings</th><th>Interviews</th></tr>
<tr><td>• Difficulties in extracting accurate data from the vast amount of data on the internet
• Needs of studying the use of data for differentiating from other competitors</td><td>Björk & Eppler & Mengis, 2004; Kusiak & Tang, 2006; Ottosson, 2008; Schon,1983</td><td>• High level of use of web search engine and concerns about its reliability
• Individual autonomy when collecting and selecting ideas
• Needs of systematic data selection process</td><td>D.1
D.3</td></tr>
<tr><td colspan="4">Conformance or contradiction between theoretical and empirical studies: Conformance</td></tr>
<tr><td colspan="4">Insight: Combining individual autonomy with company’s systematic method in data selection might be useful for obtaining high-quality insights.</td></tr>
<tr><td colspan="4">Key Words: Data Selection, Internet Environment, Reliability</td></tr>
</table>

Table 91. Summary of discussion of difficulties in accurate information selection

Different Language and Mistrust

Language barriers and the resulting mistrust and uncertainty were mentioned frequently in the multiple interviews within this study. Several studies on cross-functional tasks have also identified the impact of language barriers on the progress of NPD, especially between research- and practice-centred teams (e.g. Griffin et al., 1996; Gupta et al., 1985; Leenders & Wierenga, 2002). Griffin and Hauser’s research (1996) of ‘Integrating R&D and marketing’ described a large gap between the characteristics of marketing (research-centred) and R&D (practice-centred) teams; for example, a marketing team showed a high tolerance for an ambiguous, abstract approach, but an R&D team indicated a low tolerance for the same (Saxberg & Slocum, 1968).

The empirical study also identified the specific language differences between planning, design, and engineering staff. For instance, planning teams preferred numerical evidence, while design teams arrived at insights by personal intuition and experience, and engineering teams emphasised feasibility.

In addition, the findings also confirmed that the difference in perspectives between the research-based team (planning) and the practice teams (design, engineering) is particularly prominent, which results in mistrust and uncertainty between the research and practice departments.

The theoretical basis supporting the interview findings was discovered in the following literature review. Many scholars said that, if repetitive collaborations without reducing barriers between different types of teams are continued, the barriers become more solid when preserving identity and collective culture in collaborative works (e.g. Dougherty, 1992; Slater & Narver 1995; White et al., 2008). Furthermore, it has been established that these barriers can cause mistrust between different teams, which might result in unsuccessful outcomes for their projects (Griffin & Hauser, 1996). For these reasons, a number of scholars suggest that reducing language barriers is important in a collaboration-centred process of NPD, because mistrust often brings uncooperative behaviour between different functional teams and results in ineffective NPD activity (e.g. Massey et al., 2007; McAllister, 1995; Rousseau et al.,1998). In this regard, this study has identified a lack of synthesis of various perspectives in the recent NPD system, which results in high language barriers. In addition, it has found the need for better integration of the opinions of diverse experts, especially regarding consumer data (see Table 92).

Topic. Different Language and Mistrust			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Difference in languages between marketing and R&D • Mistrust caused by language barrier, and its impact on outcomes of NPD • Importance of decreasing language barrier	Griffin & Hauser, 1996; Leenders & Wierenga, 2002; Massey et al., 2007; McAllister, 1995	• Different languages among different functional teams • Significant gap in language between research-based (planning) and practice-based (design, engineering) teams • Mistrust caused by language barrier • Need to establish common language, especially for consumer data	D.2 D.3 D.4 D.5 A.5
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Language barrier (difference in ways of getting insights) between research-based and practice-based teams affects level of mistrust and outcomes of NPD.			
Key Words: Different language, Language barrier, Mistrust, Bridge			

Table 92. Summary of discussion of different language and mistrust

Stimulus Data

In academic research, stimulus data has been generally defined as the data affecting a human's mental flow process (Bachmann,1989; Koenemann et al., 2003), and many researchers have investigated characteristics of the data and its potential to stimulate idea generation and insights (e.g. Sindakis, 2017; Wright, 2016). These studies on stimulus data suggest that exploring the recent tendency of data collection and use can be helpful for building a systematic process to yield valuable data that would stimulate competitive ideas and new insights (Flint, 2002; Van Kleef et al., 2005). The exploration of knowledge of data usage patterns can help to enable people to use multiple stimulus data flexibly, depending on their purpose and context; this could, in turn, lead to the better discovery of meaningful information that would bring about innovative insights (Aho et al., 1986).

This study has investigated the nature of data used by multiple functional teams and discovered the common or different features between them. As a result, this study has established that a potentially large gap may exist in data meant to stimulate idea generation and insights across different functional teams. Also, this study has identified that the methods for obtaining data and insights is affected by a team's own expertise and role within the front end of NPD. It has also determined that a lack of understanding of other teams' methods of obtaining insights creates mistrust (see Table 93).

Topic. Stimulus Data			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Importance of research on the various types of data stimulating new ideas • Opportunities to improve the quality of stimulus data through the use of appropriate kinds of data, depending on the situation	Aho et al., 1986; Bachmann, 1989; Flint, 2002; Van Kleef et al., 2005; Wright, 2016	• Different tendencies in use of data for stimulating new ideas between different functional teams • Mistrust caused by a lack of understanding of other teams' methods of getting insights	D.2 D.3 D.4
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Different expertise groups have different ways of using data and information to stimulate insights, which mainly comes from diverse expertise and roles in NPD			
Key Words: Stimulus Data, Different language, Insights			

Table 93. Summary of discussion of stimulus data

Mistrust of Qualitative Data

This study confirms that most of the practice-based teams' interviewees have a high level of mistrust in qualitative data analysed by the research division, because subjective interpretation of the information is the core characteristic of qualitative data analysis (Jeans, 1992; Khun, 1963). Specifically, since consumer data form a key part of the qualitative data affecting the future success of today's NPD results (Brown & Eisenhardt, 1995; Van Kleef et al., 2005), practice-based teams showed high levels of mistrust in consumer data results from research-based teams.

Some research is sceptical about the importance of consumer needs data, since they believe that even consumers do not know what they need in the future within our unpredictable market environment (Ulwick, 2002). Similarly, some interviewees from the study mentioned that recent consumer lifestyles often follow the evolution of technology, rather than new products following consumer needs. To sum up, data on consumers is still regarded as a core factor affecting successful NPD outcomes in theoretical studies and real industry. Furthermore, companies will need the ability to anticipate how customer's new life patterns will emerge from new technology, due to rapid development in technology today. For this reason, practice-based teams' appropriate involvement in the qualitative research (i.e. consumer survey) has the potential to reduce mistrust of the research results, and therefore internal data would potentially be used more directly to stimulate the creation of new ideas across the company (see Table 94).

Topic. Mistrust of Qualitative Data			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Main characteristic of qualitative data: subjective analysis • Importance of consumer data • Possibility of discrepancy between present and future consumer needs	Brown & Eisenhardt, 1995; Jeans, 1992; Ulwick, 2002; Van Kleef et al., 2005	• Mistrust about qualitative data analysed by subjective views • Low level of using internal data due to mistrust in qualitative results • Common recognition of importance of consumer data • Recent tendency that consumer lifestyle follows technology changes	D.2 D.3 D.5 B.1 B.2
Conformance or contradiction between theoretical and empirical studies: Conformance			
Insight: Blending perspectives of research- and practice-based teams on qualitative research (i.e. consumer research) can contribute to reducing mistrust and raise the level of internal data use			
Key Words: Mistrust, People's Involvement, Qualitative Data, Consumer Data			

Table 94. Summary of discussion of mistrust in qualitative data

Complexity to Simplicity of Information

Internet developments continue to result in an enormous amount of information (Hatchuel et al., 2010; Kusiak & Tang, 2006). Strategic methods for converting complex information into simplified and usable data is becoming more important (Collinson & Jay, 2012; Van de Ven, 1992). This study found two key factors that potentially contribute to simplified and usable data: 1) visualisation of information, and 2) an establishment of a core range of information that helps to select key data directly related to projects out of a vast amount of information (i.e. creation of guidance for navigation of large data sets, and identification of vital data). One of the main reasons for performing visualisation of information is that it would enable people to understand complex concepts more easily (Keller & Tergan, 2005).

Therefore, visualisation of information can be more useful for complex and mixed knowledge-based tasks such as NPD (Cox & Brna, 1995). Through several tests, Cagan and Vogel (2002), Holloway (2009), and Williams (2010) demonstrated that visualisation is effective in creative tasks, and this study also confirmed that employees in sample MNEs often use visual data as an effective way to share knowledge. For example, a planning team often uses image-formatted data to complement text-formatted data. In addition, the design team frequently uses image-formatted data to gain insights for their idea generation, while engineering teams often simplify engineering issues graphically in order to share knowledge with people who lack the technical expertise.

Furthermore, many researchers have pointed out the importance of establishing an appropriate range of key areas for data selecting to enable accurate assessment of information and reduce uncertainty (e.g. Hubbard, 2010; Majaro, 1991). Empirical research presented a corresponding result with these theoretical findings. According to the interview participants from the design and engineering teams, they are often under pressure due to time-to-market issues, so they do not have enough time to read the massive amounts of data delivered from the research teams.

For this reason, they said that it would be helpful to use internal data more efficiently and reduce uncertainty by creating more efficient data-collecting systems that can be easily navigated. This could include defining the key ranges of data or providing a guide when using large amounts of data (see Table 95).

Topic. Complexity to Simplicity of Information			
Theoretical Study		**Empirical Study**	
Key Findings	**Literature**	**Key Findings**	**Interviews**
• Benefit of visualisation of data; helping a person's cognitive ability to absorb complex information • Setting range of data for accurate evaluation of information and reduction of uncertainty within vast amounts of data	Collinson & Jay, 2012; Hubbard, 2010; Keller & Tergan, 2005; Majaro, 1991; Williams, 2010	• General use of visualisation to share complex information with other functional teams • Insufficient time to read massive size of internal data • Need for providing proper range of data for navigating core issues	D.4 D.5 C.1

Conformance or contradiction between theoretical and empirical studies: Conformance
Insight: The use of visualisation and establishing an appropriate range of key areas for data selection would enhance the utilisation of internal data, which increases the efficiency of collaborative work
Key Words: Visualisation, Range of Data, Knowledge Sharing, Size Of Data, Internal Data

Table 95. Summary of discussion of complexity to simplicity of information

Through the exploration the research question regarding data, information and insights that stimulate generating new ideas, several key insights related to potentially reducing mistrust and increasing the level of use of internal data by practice-based teams were uncovered. To lower mistrust among different teams and increase their levels of internal data use, employees need to understand other teams' stimulus data use methods (i.e. different perspectives of data use or insights). In addition, in order to reduce the language gap, blending the perspectives of research- and practice-based teams with regard to qualitative research (especially consumer surveys) can be helpful in reducing mistrust and raising the level of internal data use by practice-based teams. Furthermore, efficient systems for simplifying complicated information could enable the quality of cooperation in NPD to improve (e.g. using visualisation and establishing an appropriate range of key areas for data selection). Finally, this study identified that combining individual autonomy with a company's systematic method of data selection might be useful to obtain high-quality insights.

5.2. Summary of Discussion

In this chapter, meaningful factors related to reducing mistrust and uncertainty were identified by comparing existing theories with the findings of the empirical study (see Figures 11, 12 and 13 on p. 82-84). As a result, this chapter confirmed that integrating different perspectives about idea quality between different expertise groups is important for reducing mistrust and uncertainty when generating ideas. Also, this work identified that lack of feedback channels brings negative effect of internal conflicts in real-world projects of recent MNEs (i.e. mistrust and uncooperative tasks). Furthermore, lack of efficient systems in the idea generation stage related to providing proper rewards, allocating staff involvement to the consumer survey, and giving a guide for utilising data, appears to impact on the level of mistrust and uncertainty in the early stage of NPD.

In conclusion, this study confirmed that the lack of common language and communication channels, as well as inefficient tactics in the use of data, can affect the level of mistrust and uncertainty in the idea generation stage of NPD.

6. Conclusion

Introduction

This final chapter summarises the main findings of this research, and discusses their implications for NPD studies so that this study can contribute to new knowledge of front-end NPD. In conclusion, a framework that contributes to reducing difficulties between research activities and practical activities in the NPD processes of MNEs is provided. Furthermore, this chapter illustrates the limitations found during the research, and also proposes contribution and opportunities for related further studies.

6.1. Contribution to New Knowledge

The new knowledge derived from this study contributes to current NPD research in the following four areas.

(1) An improved model for multidisciplinary or cross-functional idea generation and development activities:

The study synthesises two widely recognised academic models, i.e., those developed by Cooper (1990) and Ulrich & Eppinger (1995). Respectively, these models present macroscopic and microscopic perspectives, though combined, they enable the current work to examine problems related to NPD front-end process from multiple angles: Namely, this study has examined the issues emerging from the whole structure and its sequence of NPD process under Cooper's model (1990). Further, Ulrich and Eppinger’s (1995) sub-activity models of NPD were used to discover issues regarding the details of teams' activities and companies' tactics for idea generation, in depth.

Further, the study identifies a discrepancy in terminology between theoretical NPD front-end models and the actual idea development process undertaken by companies in real-world situations (see p. 110). The integrated and comparative exploration set out above facilitates the rearrangement and expansion of existing NPD front-end structures (see Figure 16 on p. 111), and thus provides foundations for an enhanced and more realistic model for MNEs' current multidisciplinary idea generation and development activities. This finding presents new knowledge and insights that can be used in both empirical and experimentally-oriented NPD and idea generation studies as a foundation for exploring future NPD processes.

(2) A new interpretation of the relationship between multidisciplinary approaches and NPD processes:

A review of extant literature reveals that a majority of studies in multidisciplinary approaches to the NPD process focus typically on the impacts of multidisciplinarity in terms of the generation of psychological conflicts between different departments (e.g., Lawson et al., 2009; Negroponte, 2003; Pelled et al., 1994). In contrast, the research reported here addresses the issue of multidisciplinarity and psychological implications, but moves beyond this to identify and examine ‘system-level’ factors that impact on (a) the NPD idea generation process, and (b) the mechanisms used to apply and utilise data and information in product design and development activities. The new knowledge, derived from examinations of both psychological and system issues, provides a comprehensive, practical and precise interpretation of the relationship between the multidisciplinary approach and NPD processes. It also aids MNEs' cross-functional activities, by facilitating their research outcomes in ES NPD, allowing them to be effectively applied in the subsequent prototype development phase (see ‘Transition point’ at Figure 17 on p.116 and Figure 28 on p. 236).

(3) Provision of actionable recommendations and guidance for application in Korean MNEs:

The synthesised FEI NPD framework (created within this study via combination of elements of the Cooper and Ulrich & Eppinger models, see Figure 28), offers realistic and useable guidance and recommendations that are readily applicable in the context of Korean MNEs. Previous idea generation research and existing academic models have been developed typically for general business environments (e.g., Ekerå et al., 2015; Song et al., 1998; Trott, 2012), thus are not reflective of hierarchical company culture found in Korean MNEs, one that frequently hinders the operation of optimal multidisciplinary approaches in generating innovative ideas. In addition, existing research on the hierarchical culture of Korean companies has focused primarily on the relationship between managers and employees, rather than on NPD teams or the process itself (e.g., Kim & Tung, 2013; Naser, Shobaki, & Amuna, 2016). The new FEI NPD framework presented in this study - one that focuses on streamlining of language differences, communication channels, and strategic data management systems - has been validated in multiple verification tests involving a variety of practitioners in Korean MNEs. Therefore, managers and employees in contemporary manufacturing organisations can have confidence in the appropriateness of research outputs for application in the Korean NPD context.

(4) Presentation of detailed, high quality cases that strengthen and enrich current academic knowledge in relation to NPD:

The samples in this study are derived from leading enterprises in the contemporary global industrial market (for more details, see p.101-102 of Section 3.3). Via in-depth exploration of conformances and contradictions between existing theory (as embodied in the literature) and real-world cases of successful enterprises, this study both extends existing NPD theory and contributes to its robustness and validity. In particular, it does this with regard to 'ideas' and the nature of the idea generation process, levels of uncertainty and the involvement of people and teams in idea generation activities, and the utilisation of data and information in the stimulation and generation of ideas.

The new knowledge generated by this study can also be used as a foundation to support analysis of the characteristics of Korean and/or Asian MNEs when compared with other cultures in other future studies.

6.2. Research Summary

This study implemented systematic literature reviews in three key areas of factors affecting: (i) front-end innovation (FEI) and idea generation, (ii) uncertainty in early-stage (ES) of NPD, and (iii) usage of data, information and insights (DII) within idea generation activities in ES of NPD. These were done to investigate the key themes and issues in recent NPD and front-end studies, and they set out to answer four primary research questions identified from the literature reviews (see Figure 14 on p.99). The aim of answering the research questions (RQs) was to gain an in-depth understanding of the idea generation and idea management systems currently used by Korean MNEs for NPD, to identify core factors that cause difficulties in current systems, and to increase the effectiveness of front-end processes, and thereby support the creation of innovative ideas applicable to real projects. These goals were achieved via multiple interviews with industrial MNE employees handling three main functions (planning, design, and engineering) in order to: (RQ1) discover the nature of recent idea generation processes and employees' awareness of the importance of idea quality; (RQ2) explore the reasons for initiating new projects and the correlation between the level of people or team involvement and the efficiency of front-end systems; (RQ3) determine the factors affecting uncertainty during the process of generating and developing ideas; and (RQ4) investigate the types of data that employees are usually stimulated by when generating new ideas. In particular, the answers to these four research questions were compared between different functional teams in order to explore problems occurring within real cross-functional tasks and to find practical opportunities for current idea generation processes. Based on Cooper's NPD model (1990), this study divided the front-end phase into two simple stages, focus and direction, so that interview participants could easily understand the front-end activities and conduct smooth interviews. Also, the research area of this study was expanded to the development stage so as to identify the impact of the front-end stage results on the practice division's primary works in the development stage (i.e. to identify factors affecting a lack of qualitative collaboration between research and practice). Multiple interviews and surveys in this study supplied answers to the four research questions and confirmed existing issues that occurred in recent NPD activities. Furthermore, through an in-depth comparative analysis of these findings, the following specific factors leading to mistrust and uncertainty were revealed, which may ultimately affect the difficulties between research activities and practical activities (see 'Transition point' at Figure 17 on p.116 and Figure 25 on p. 234).

Firstly, this study found that the characteristics of NPD works are changed after the direction stage, and that most employees were aware of this change in their NPD projects (transition from research activities to practice activities, see Figure 17 on p.116). The empirical study identified that people from different functional teams commonly acknowledge the importance of the front-end stage because they are aware that the crucial decisions are made at this stage, and the results typically affect the performance of the later development stages. Also, the evaluation criteria of idea quality were significantly different among the three sample teams, which bring mistrust between them. The synthesised insights of this study showed that, in order to generate successful high-quality ideas in the idea generation stage, there is a need to reduce mistrust between different expert groups. This can be accomplished by establishing a system that can maximise the efficiency of integrating different perspectives and ideas between them (establishing common language).

Secondly, the interview participants stated that they felt their companies' current idea generation systems are inefficient. This study has specifically identified two factors related to inefficient idea integration systems that potentially bring mistrust and uncertainty: the low level of involvement of practice-based teams in idea generation phase, and the low level of motivation of people in multidisciplinary teams due to a lack of proper rewards for their ideas.

The empirical study outcomes demonstrate that the level of involvement of design and engineering teams in the front-end phase is much lower than that of the planning team, which causes mistrust and uncertainty due to a lack of sufficient feedback exchange. In other words, this is due to the absence of appropriate communication and feedback exchange methods, which can hinder any chances to understand or integrate different perspectives of information when generating ideas. This study has established, within the MNEs sample, that their potential to dramatically improve their NPD output results if multiple teams are allowed to provide a variety of ideas prior to the NPD concept being defined. In addition, the introduction of appropriate reward and feedback systems would also contribute to improving the quality of outcomes of multidisciplinary approaches for idea integration, as current reward systems of sample MNEs have resulted in a lack of motivation of participants within multidisciplinary team activities.

From these findings, this study has identified that increasing a more balanced level of diverse people skills and introducing more effective engagement practices have the potential to increase employees' motivation in the idea generation stages and to improve the generation of high-quality ideas.

Thirdly, the investigation showed a gap between research- and practice-based teams on the level of uncertainty. The planning team revealed the highest level of uncertainty in the direction stage, while the design and engineering teams showed the highest level of uncertainty in the development stage. In other words, this study discovered a correlation between levels of team involvement and their level of uncertainty, because a planning team typically leads the direction stage and the design and engineering teams lead the development stage. Furthermore, the findings showed that the uncertainty is emanating from difficulties in conversing with other teams due to their different way of thinking, especially between the planning and design/engineer teams. In this regard, this study identified that there are potentially more opportunities to reduce uncertainty in idea generation if an efficient system for establishing common languages between teams is developed in the front-end phase. This would ensure that each team can better understand other teams' perspectives of the product context and ideas and improve the confidence in their main work during NPD projects.

Lastly, this study also examined how each team uses data and information to stimulate idea generation and has identified differences in the use of data between the diverse teams. In summary, the planning team prefers to use data established numerically or logically; designers prefer open-ended data upon which they can embed their personal experiences or intuition; and engineers often apply the data immediately to a practical assessment for checking feasibility. This gap in concept-sets and perspectives of driving data and insights (especially consumer data) causes the design and engineering teams' low usage level of internal data delivered from research-based divisions. In particular, the design and engineering teams expressed doubts about the qualitative internal data since it is typically filtered and analysed by the research-based teams' subjective views. Furthermore, the internal data's massive size and duplicated contents were mentioned as a reason why many employees conducting practical development fail to use internal data effectively. In this regard, this study discovered that combining individual autonomy with a company's systematic method of driving data (i.e. data collection, selection, and analysis) might be useful to obtain high-quality insights while generating ideas and developing real products, and also identified the need for methods of simplifying data.

Through analysis of the findings on the four research questions, this study identified that issues arise mainly from the following three system factors: (i) lack of a common language between each functional team, (ii) lack of appropriate communication channels, and (iii) lack of tactics in using internal information (see Figure 25, and see Figures 21, 22, and 23 on p.196-198 for more details of identified issues). The study found that these factors bring mistrust (particularly between the research and practice divisions), as well as uncertainty within cross-functional work of NPD. In addition, this study identified that factors that affect mistrust and uncertainty eventually cause an ineffective collaboration between research results and practical activities within the cross-functional tasks of MNEs'

NPD. Furthermore, the study findings revealed that the following three implications can potentially arise due to the ineffective collaboration between research activities and practical activities in ES NPD: (i) misuse of internal data expertise, (ii) missed opportunities for improving quality of ideas and products, and (iii) missed market opportunities (Figure 26).

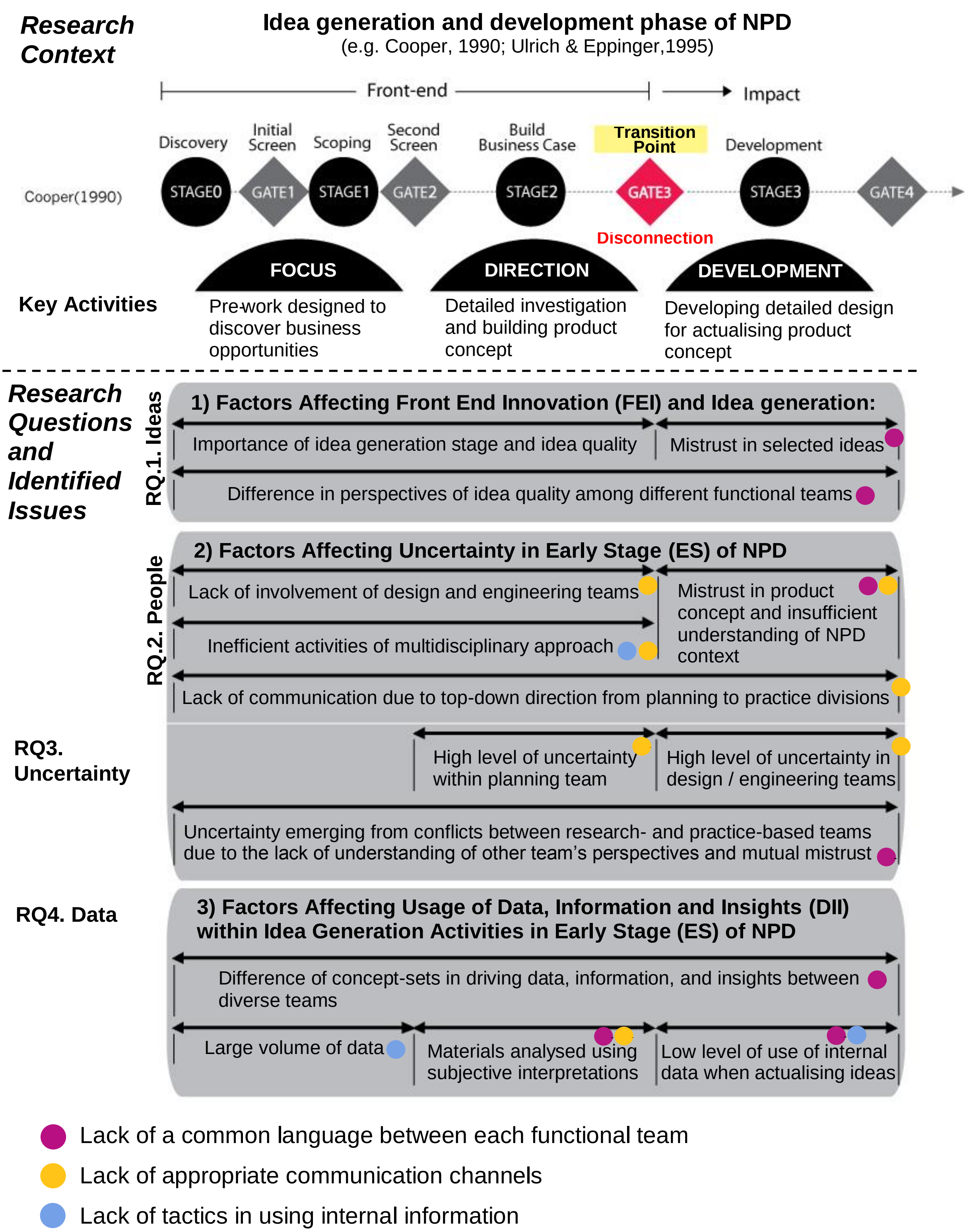


Figure 25. Research on a page

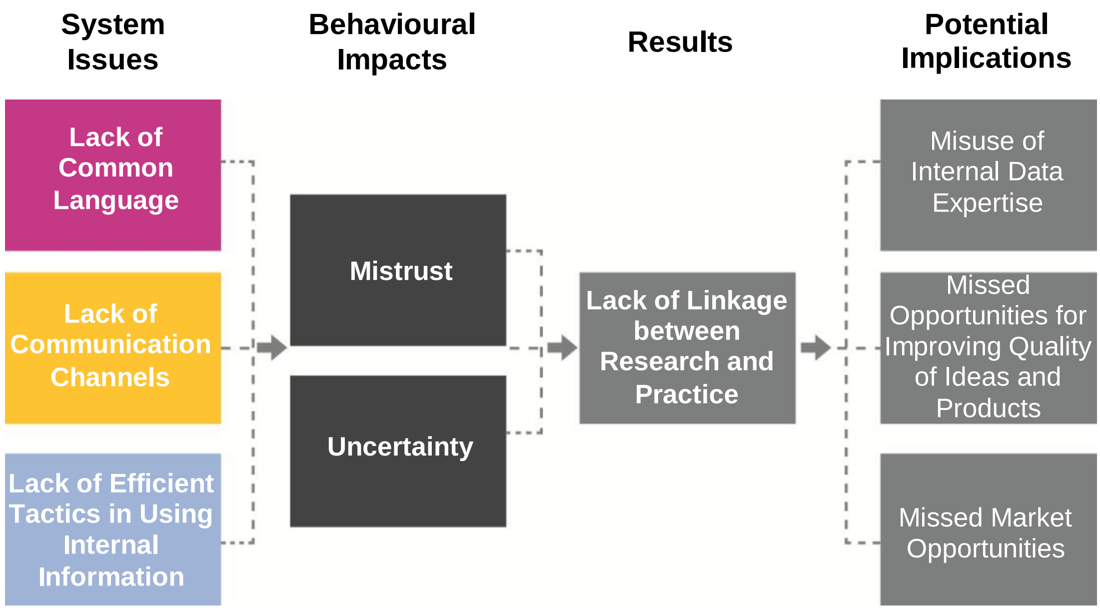


Figure 26. Synthesis of findings

6.3. Idea Generation Framework

Through exploring theoretical and empirical studies, the idea generation framework has been revised and developed to attempt to reduce mistrust and uncertainty. The proposed framework sets out with the goal that the identified issues could be flipped into opportunities to potentially reduce mistrust and uncertainty (Figure 27).

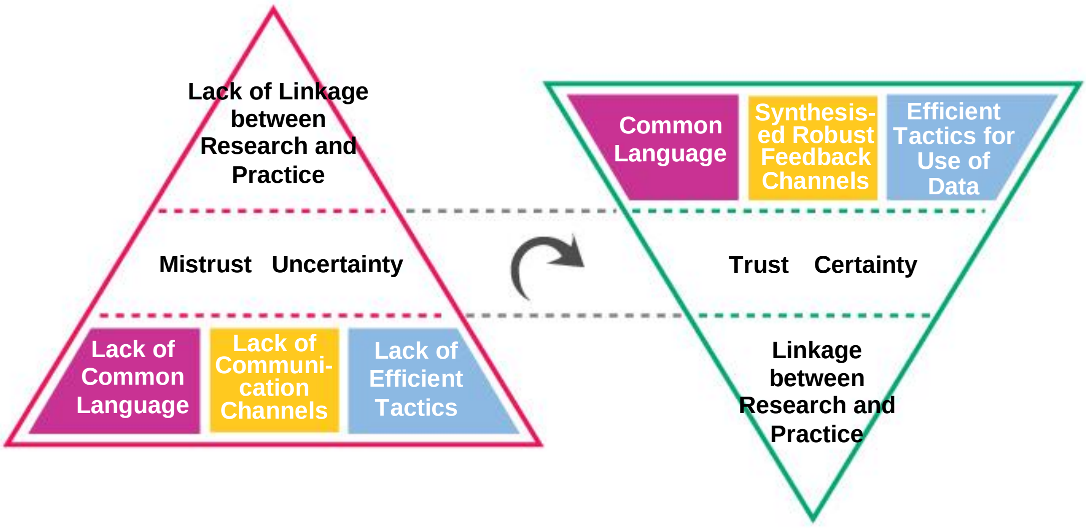


Figure 27. Flipped opportunity model

The suggested flipped opportunity model in Figure 27 and the flipped opportunity elements in Figure 28 have the potential to improve the idea generation process and contribute to obtaining high-quality ideas.

The flipped opportunity elements model (Figure 28) shows that establishing sufficient channels between different functional teams for the exchange of feedback is the basis of potentially reducing the level of mistrust and uncertainty in ES NPD.

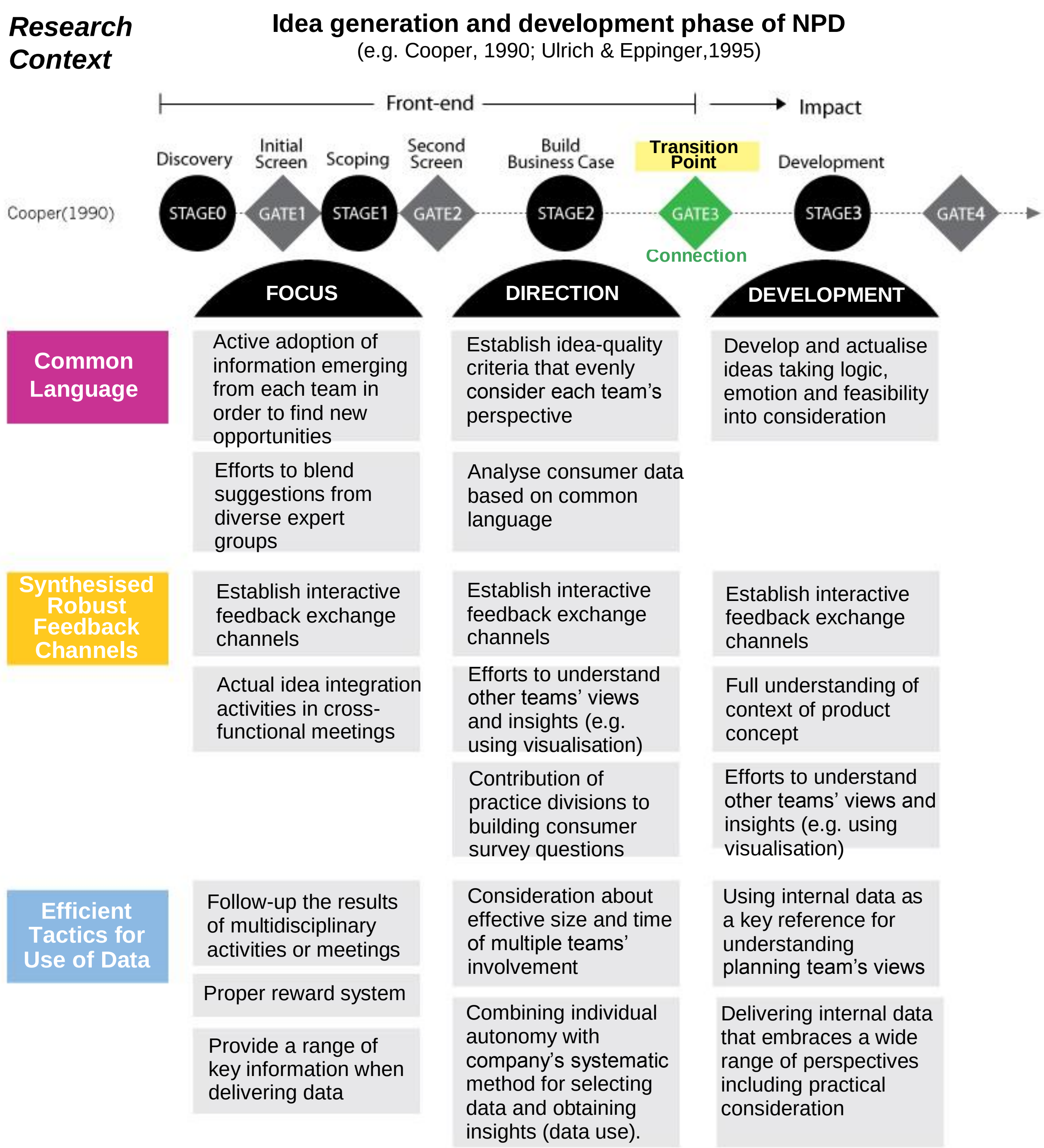


Figure 28. Flipped opportunity elements

In the focus stage, the planning team is asked to screen initial market potential using a variety of perspectives, including those of the design and engineering teams, so that various types of knowledge can be blended. In addition, it attempts to improve the efficiency of the multidisciplinary approach by providing proper reward and follow-up systems pertaining to the outcomes. The main purpose of the cross-functional meetings should be changed from reporting existing issues to actually integrating diverse ideas from different expert groups without being afraid of challenging any issues. In addition, giving a proper range of internal data might be helpful so as to use internal data efficiently in the limited time frame.

The main ideas for building a product concept are analysed and selected in the direction stage. This study found that each functional team has different methodologies for analysing data and information (planning: rational and logical insights; design: emotional and intuitional inspiration; engineering: consideration of feasibility and verification) and defining central idea quality (planning: consumer benefit; design: novelty; engineering: feasibility). Specifically, this study has identified that blending individual autonomy (each person or team's preferred methods) and a company's systematic method of driving data and insights is vital. This enables maximisation of efficiency in integrating different perspectives to obtain high-quality insights. The study also found that employees are aware of the benefit of different types of perspectives when defining idea quality; therefore, they want and need a synthesis of diverse languages to generate high-quality ideas, as well as an understanding of other experts' views. In this case, visualisation of ideas could be useful for a better understanding of different concept-sets. These findings sparked a consideration of the need for designers and engineers to contribute to generating and selecting ideas in the front-end phase, so that the outcomes in the front-end phase are enriched.

This study has focused on how the activities of the front-end stage impact the realisation of ideas in the development phase. Throughout multiple interviews, concerns about actualising ideas without fully understanding their context were frequently mentioned. Increased feedback exchange and activities for integrating different languages in the front-end phase could potentially make the practice-based work easier in the development stage, as these activities can lead to a better understanding of the product concept's context on the part of the designers

and engineers. In addition, in order to maintain a state of integrated knowledge using a common language, FEI NPD achievements need to be underpinned by a continuous feedback exchange between the planning and design/engineering teams in the development stage.
Decreasing mistrust and uncertainty will help to boost the use of internal data for actual practical works on the part of designers and engineers. Based on their increased trust in the research division’s information and a better understanding of the idea’s context, the designers and engineers can better use materials from the research teams to more effectively materialise the concept. At the same time, giving designers and engineers increased space to obtain insights themselves using their own methods has the potential to increase efficiency, which constitutes the same tactics as used in the previous stages. For example, rather than the design and engineering teams using internal data to meet specific requirements, it could be used for the purpose of understanding the planning team’s perspectives and insights.

In summary, this study suggests that the issues affecting difficulties in idea generation activities in FEI NPD can be converted to new opportunities that have the potential of establishing effective collaboration between research-based and practice-based teams.

6.4. Limitations

When conducting critical thinking and research, many studies emphasise acquiring insights through the integration of related themes from in-depth research on specific topics, rather than investigating a broad range of topics (Drane, 2001; Powell et al., 1985; Sizer, 1984). In response, this study confined the research area to the stages directly related to generating ideas in the NPD process and established the research sample as MNEs. The sample companies in this study produce automobiles and various types of consumer electronic appliances that are considered hardware-centric. However, as smart devices become more popular and software use and development becomes more common in the sample companies, it is expected that the results of this study will be applicable to various kinds of industrial MNEs (whether software- or hardware-centric). The study is limited as to whether the findings and suggestions can be applied to small-scale industrial companies. Since it mainly conducted an in-depth analysis of issues related to the limitations of large organisations, the research results may not fit small-sized companies. However, it is believed that research on the nature of each functional team in the idea generation stages can be used effectively, regardless of the size of the company.

Another limitation of this study is the question of how the factors influenced by a specific management culture can work in other management cultures. The research sample of this study is focused on MNEs that produce products influenced by Korean management culture but which target global consumers. Although the conclusions of this study were derived from an environment affected by specific management cultures, it would be worthwhile to apply the findings to industrial MNEs in other cultures. This is because the industrial MNEs underlying NPD process structures are common across the world, and the sample organisations of this study are key companies in a group that leads the global industrial market. The empirical study was composed mainly of multiple interviews with a sample of senior members with 5 to 10 years' experience within each MNE, while some have been managers or directors for over 20 years. The possibility of differences in the level of involvement and activities in the idea generation stages, depending on project experience, career, and position, may be another limitation of this study.

6.5. Opportunities for Future Research

This study has identified three key factors that affect mistrust and uncertainty within FEI NPD:

(i) Lack of a common language between each functional team
(ii) Lack of appropriate communication channels
(iii) Lack of efficient tactics in using internal information

These findings could be fundamental in future research related to effective front-end activities.

(i) In connection with the findings of this study, considerably more work on common language is required. For example, a future study could investigate the detailed elements that contribute to the practical integration of different perspectives, as well as examine in depth how the different language affects each expert's behaviour and mindset within idea integration process.

(ii) This study has brought to light the need for future research into how to establish sufficient feedback exchange channels in the idea generation stage. In particular, this study identified that it is difficult to provide communication opportunities for all employees because of the size of the organisation and time pressures within MNEs' NPD environment. Future studies could focus on practical ways of effectively allocating human resources at each stage to improve communication channels.

(iii) A low level of use of internal data was the core issue faced by the sample MNEs. This study identified that many MNEs' budget expenditure on the production of internal data is significant, but the level of actual use of the data is poor. In this regard, future studies could investigate more efficient methodologies for driving multiple types of internal data.

This study's main focus was on the internal or organisational factors that affect the FEI NPD performance of MNEs. To complement this study, an in-depth examination of the external factors that affect FEI NPD would be of assistance in decreasing levels of uncertainty for MNEs undertaking NPD processes, as there is a strong correlation between external and internal factors in the environment in which companies are required to cope with unexpected market change (Collinson & Jay; 2012; Pink, 2006).

6.6. Reflection and Summary

To conclude, this systematic investigation enabled this study to successfully answer the four research questions. It also identified potential strategies to help to solve disconnection problems between the front-end and development stages.

Through in-depth literature reviews and multiple interviews and surveys with personnel actively working in the heart of the industrial field, this study acquired key insights and meaningful answers related to the idea generation and development activities in front-end phase of NPD.

This study contributes to the enrichment of the contents of the idea management, front-end, and NPD research area (1) by comparing and analysing key issues between existing theory and real-world front-end practice of industrial MNEs, and (2) developing a practical framework that industrial MNEs can readily apply.

In addition, it suggests a direction for future front-end research; it also expects that the obtained outcomes will help to contribute to the debate of how to clarify the meaning and significance of future research in the field.

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Appendix.

Appendix 1. SPSS: The nature of the idea generation process – Individual based-tasks

Wilcoxon signed rank test: two-related sample

Test Statistics[a]

Individual-Team works	Planning	Design	Engineer
Z	-2.859^{b}	-1.151^{b}	-2.060^{b}
Asymp. Sig. (2-tailed)	.004	.250	.039

H0: The results between two samples (individual-based vs team-based) are statistically the same
H1: The results between two samples (individual-based vs team-based) are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H0 = bold lined box

Appendix 2-1. SPSS: Defining importance of idea quality

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.
2	The median of Feasibility equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.012	Reject the null hypothesis.
3	The median of BusinessObjectives equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.072	Retain the null hypothesis.
4	The median of Capability equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
5	The median of MarketPotential equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.
6	The median of ConsumerBenefit equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.958	Retain the null hypothesis.
7	The median of GutFeeling equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.369	Retain the null hypothesis.
2	The median of Feasibility equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
3	The median of BusinessObjectives equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.
4	The median of Capability equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
5	The median of MarketPotential equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.025	Reject the null hypothesis.
6	The median of ConsumerBenefit equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.204	Retain the null hypothesis.
7	The median of GutFeeling equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.683	Retain the null hypothesis.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.023	Reject the null hypothesis.
2	The median of Feasibility equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.157	Retain the null hypothesis.
3	The median of BusinessObjectives equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.066	Retain the null hypothesis.
4	The median of Capability equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.034	Reject the null hypothesis.
5	The median of MarketPotential equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.102	Retain the null hypothesis.
6	The median of ConsumerBenefit equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.109	Retain the null hypothesis.
7	The median of GutFeeling equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.039	Reject the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Novelty / Originality
2. Feasibility
3. Business objectives
4. Fit with capability
5. Market potential
6. Consumer benefit
7. Gut feeling

Appendix 2-2. SPSS: Defining importance of idea quality

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.023	Reject the null hypothesis.
2	The median of Feasibility equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.034	Reject the null hypothesis.
3	The median of BusinessObjectives equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.066	Retain the null hypothesis.
4	The median of Capability equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.157	Retain the null hypothesis.
5	The median of MarketPotential equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.102	Retain the null hypothesis.
6	The median of ConsumerBenefit equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.109	Retain the null hypothesis.
7	The median of GutFeeling equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.039	Reject the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Novelty / Originality
2. Feasibility
3. Business objectives
4. Fit with capability
5. Market potential
6. Consumer benefit
7. Gut feeling

Kruskal wallis test: pairwise comparisons

Originality/Novelty

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-.721	4.719	-.153	.879	1.000
Engineering-Design	10.718	4.301	2.492	.013	.038
Product Plan-Design	9.997	3.817	2.619	.009	.026

Feasibility

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-5.209	3.805	-1.369	.171	.513
Design-Engineering	-12.273	4.288	-2.862	.004	.013
Product Plan-Engineering	7.064	4.705	1.501	.133	.400

Gut Feeling

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	.721	4.751	.152	.879	1.000
Product Plan-Design	9.003	3.842	2.343	.019	.057
Engineering-Design	8.282	4.329	1.913	.056	.167

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 3-1. SPSS: Defining effectiveness of idea quality

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.047	Reject the null hypothesis.
2	The median of Feasibility equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.054	Retain the null hypothesis.
3	The median of BusinessObjectives equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
4	The median of Capability equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.107	Retain the null hypothesis.
5	The median of MarketPotential equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.013	Reject the null hypothesis.
6	The median of ConsumerBenefit equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.725	Retain the null hypothesis.
7	The median of GutFeeling equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.046	Reject the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.369	Retain the null hypothesis.
2	The median of Feasibility equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
3	The median of BusinessObjectives equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of Capability equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
5	The median of MarketPotential equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.003	Reject the null hypothesis.
6	The median of ConsumerBenefit equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.188	Retain the null hypothesis.
7	The median of GutFeeling equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.481	Retain the null hypothesis.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
2	The median of Feasibility equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.389	Retain the null hypothesis.
3	The median of BusinessObjectives equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.025	Reject the null hypothesis.
4	The median of Capability equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.610	Retain the null hypothesis.
5	The median of MarketPotential equals 4.90.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
6	The median of ConsumerBenefit equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
7	The median of GutFeeling equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.121	Retain the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell * Highest example = bold lined box
1. Novelty / Originality 2. Feasibility 3. Business objectives 4. Fit with capability 5. Market potential
6. Consumer benefit 7. Gut feeling

Appendix 3-2. SPSS: Defining effectiveness of idea quality

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Originality is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.021	Reject the null hypothesis.
2	The distribution of Feasibility is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.279	Retain the null hypothesis.
3	The distribution of BusinessObjectives is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.247	Retain the null hypothesis.
4	The distribution of Capability is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.136	Retain the null hypothesis.
5	The distribution of MarketPotential is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.166	Retain the null hypothesis.
6	The distribution of ConsumerBenefit is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.787	Retain the null hypothesis.
7	The distribution of GutFeeling is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Kruskal wallis test: pairwise comparisons

Originality/Novelty

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	5.350	4.688	1.141	.254	.761
Product Plan-Design	10.497	3.791	2.769	.006	.017
Engineering-Design	5.147	4.272	1.205	.228	.685

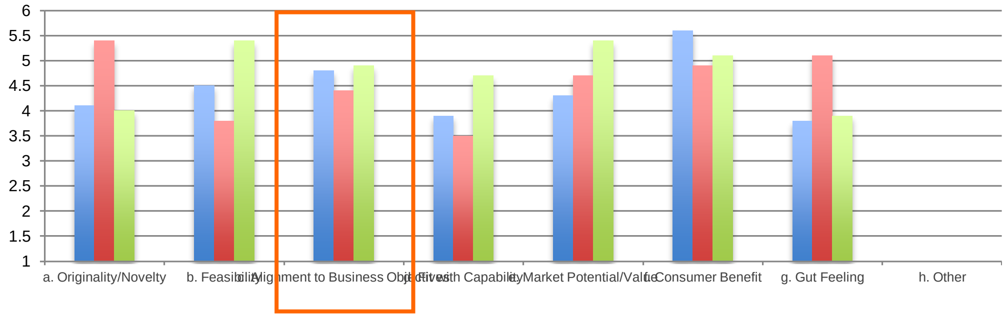
Gut Feeling

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-1.079	4.755	-.227	.821	1.000
Engineering-Design	11.223	4.333	2.590	.010	.029
Product Plan-Design	10.144	3.845	2.638	.008	.025

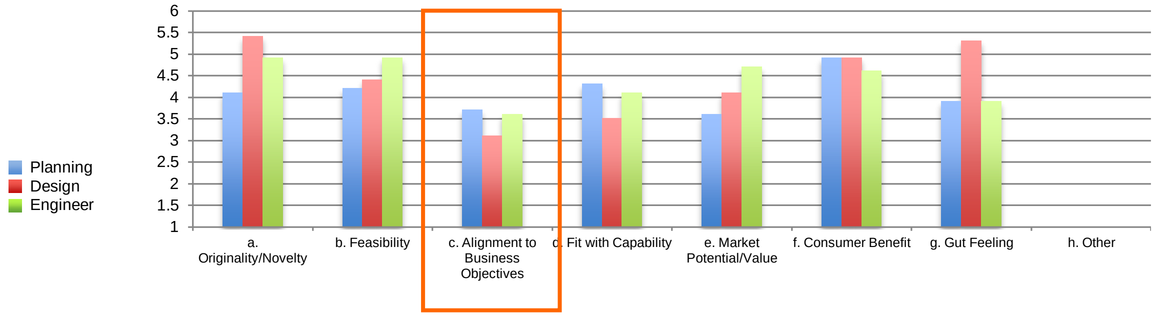
H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Novelty / Originality 2. Feasibility 3. Business objectives 4. Fit with capability 5. Market potential
6. Consumer benefit 7. Gut feeling

Appendix 4. Comparison graph: Defining idea quality – Importance vs Effectiveness



Defining idea quality – Importance



Defining idea quality - Effectiveness

* Business Objectives = bold lined box
a. Novelty / Originality b. Feasibility c. Business objectives d. Fit with capability e. Market potential
f. Consumer benefit g. Gut feeling h. Other

Appendix 5-1. SPSS: Factors frequently used when defining idea quality

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
2	The median of Feasibility equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.039	Reject the null hypothesis.
3	The median of BusinessObjectives equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.782	Retain the null hypothesis.
4	The median of Capability equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.012	Reject the null hypothesis.
5	The median of MarketPotential equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.021	Reject the null hypothesis.
6	The median of ConsumerBenefit equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.710	Retain the null hypothesis.
7	The median of GutFeeling equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.683	Retain the null hypothesis.
2	The median of Feasibility equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.683	Retain the null hypothesis.
3	The median of BusinessObjectives equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.518	Retain the null hypothesis.
4	The median of Capability equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.009	Reject the null hypothesis.
5	The median of MarketPotential equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.
6	The median of ConsumerBenefit equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.613	Retain the null hypothesis.
7	The median of GutFeeling equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
2	The median of Feasibility equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.490	Retain the null hypothesis.
3	The median of BusinessObjectives equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.206	Retain the null hypothesis.
4	The median of Capability equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.490	Retain the null hypothesis.
5	The median of MarketPotential equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.061	Retain the null hypothesis.
6	The median of ConsumerBenefit equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
7	The median of GutFeeling equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Novelty / Originality
2. Feasibility
3. Business objectives
4. Fit with capability
5. Market potential
6. Consumer benefit
7. Gut feeling

Appendix 5-2. SPSS: Factors frequently used when defining idea quality

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Originality is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.013	Reject the null hypothesis.
2	The distribution of Feasibility is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.127	Retain the null hypothesis.
3	The distribution of BusinessObjectives is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.111	Retain the null hypothesis.
4	The distribution of Capability is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.015	Reject the null hypothesis.
5	The distribution of MarketPotential is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.609	Retain the null hypothesis.
6	The distribution of ConsumerBenefit is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.075	Retain the null hypothesis.
7	The distribution of GutFeeling is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.593	Retain the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Novelty / Originality
2. Feasibility
3. Business objectives
4. Fit with capability
5. Market potential
6. Consumer benefit
7. Gut feeling

Kruskal wallis test: pairwise comparisons

Originality and Novelty

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-3.364	4.736	-.710	.477	1.000
Engineering-Design	11.450	4.316	2.653	.008	.024
Product Plan-Design	8.085	3.830	2.111	.035	.104

Capability

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-.229	3.853	-.060	.953	1.000
Design-Engineering	-11.958	4.341	-2.754	.006	.018
Product Plan-Engineering	11.729	4.764	2.462	.014	.041

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 6. SPSS: Reasons for the initiation of new projects

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.877	Retain the null hypothesis.
2	The median of DesignTrend equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
3	The median of ExistingProblems equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.012	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.796	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.328	Retain the null hypothesis.
6	The median of NewTechnology equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.021	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.133	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
10	The median of LegalIssue equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
11	The median of Other equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.718	Retain the null hypothesis.
2	The median of DesignTrend equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
3	The median of ExistingProblems equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.514	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.327	Retain the null hypothesis.
6	The median of NewTechnology equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.276	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
10	The median of LegalIssue equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
11	The median of Other equals 5.35.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.157	Retain the null hypothesis.
2	The median of DesignTrend equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.
3	The median of ExistingProblems equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.024	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.041	Reject the null hypothesis.
5	The median of CompetitiveProducts equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.
6	The median of NewTechnology equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.038	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.026	Reject the null hypothesis.
8	The median of FinancialEffect equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
10	The median of LegalIssue equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.043	Reject the null hypothesis.
11	The median of Other equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products
6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect
10. Legal issue 11.Other

Appendix 7-1. SPSS: Importance of teams' involvement in the idea generation stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of communicationP equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.317	Retain the null hypothesis.
2	The median of communicationD equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.015	Reject the null hypothesis.
3	The median of communicationE equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
4	The median of communicationO equals 6.00.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of communicationP equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.003	Reject the null hypothesis.
2	The median of communicationD equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.607	Retain the null hypothesis.
3	The median of communicationE equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.003	Reject the null hypothesis.
4	The median of communicationO equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.941	Retain the null hypothesis.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of communicationP equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.038	Reject the null hypothesis.
2	The median of communicationD equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.083	Retain the null hypothesis.
3	The median of communicationE equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.034	Reject the null hypothesis.
4	The median of communicationO equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.039	Reject the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Planning team
2. Design team
3. Engineering team
4. Others (Multidisciplinary team)

Appendix 7-2. SPSS: Importance of teams' involvement in the idea generation stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of InvolvementP is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.007	Reject the null hypothesis.
2	The distribution of InvolvementD is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.118	Retain the null hypothesis.
3	The distribution of InvolvementE is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.009	Reject the null hypothesis.
4	The distribution of InvolvementO is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.007	Reject the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Planning team
2. Design team
3. Engineering team
4. Others (Multidisciplinary team)

Kruskal wallis test: pairwise comparisons

Involvement of Planning team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-1.231	4.159	-.296	.767	1.000
Design-Product Plan	-11.338	3.691	-3.072	.002	.006
Engineering-Product Plan	-10.107	4.564	-2.215	.027	.080

Involvement of Engineer team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	10.532	3.739	2.817	.005	.015
Product Plan-Engineering	11.579	4.623	2.505	.012	.037
Design-Engineering	-1.046	4.213	-.248	.804	1.000

Involvement of Other team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	7.546	3.577	2.109	.035	.105
Engineering-Product Plan	-12.429	3.926	-3.166	.002	.005
Design-Product Plan	-4.882	3.175	-1.538	.124	.372

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 8-1. SPSS: Effectiveness of teams' involvement in the idea generation stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InvolvementP equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.359	Retain the null hypothesis.
2	The median of InvolvementD equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.
3	The median of InvolvementE equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
4	The median of InvolvementO equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InvolvementP equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
2	The median of InvolvementD equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.553	Retain the null hypothesis.
3	The median of InvolvementE equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.030	Reject the null hypothesis.
4	The median of InvolvementO equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InvolvementP equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
2	The median of InvolvementD equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.206	Retain the null hypothesis.
3	The median of InvolvementE equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.490	Retain the null hypothesis.
4	The median of InvolvementO equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Planning team
2. Design team
3. Engineering team
4. Others (Multidisciplinary team)

Appendix 8-2. SPSS: Effectiveness of teams' involvement in the idea generation stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of InvolvementP is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of InvolvementD is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.004	Reject the null hypothesis.
3	The distribution of InvolvementE is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
4	The distribution of InvolvementO is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.432	Retain the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Planning team
2. Design team
3. Engineering team
4. Others (Multidisciplinary team)

Kruskal wallis test: pairwise comparisons

Involvement of Planning team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-2.340	4.322	-.541	.588	1.000
Design-Product Plan	-15.062	3.836	-3.927	.000	.000
Engineering-Product Plan	-12.721	4.743	-2.682	.007	.022

Involvement of Design team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	10.379	3.617	2.870	.004	.012
Product Plan-Engineering	12.921	4.472	2.889	.004	.012
Design-Engineering	-2.542	4.076	-.624	.533	1.000

Involvement of Engineer team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	11.979	3.854	3.109	.002	.006
Product Plan-Engineering	16.807	4.765	3.527	.000	.001
Design-Engineering	-4.828	4.342	-1.112	.266	.799

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 9. SPSS: Level of uncertainty

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of FOCUS equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
2	The median of DIRECTION equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.358	Retain the null hypothesis.
3	The median of DEVELOPMENT equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of FOCUS equals 5.00.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
2	The median of DIRECTION equals 5.00.	One-Sample Wilcoxon Signed Rank Test	.499	Retain the null hypothesis.
3	The median of DEVELOPMENT equals 5.00.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of FOCUS equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.
2	The median of DIRECTION equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.126	Retain the null hypothesis.
3	The median of DEVELOPMENT equals 5.30.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Focus stage
2. Direction stage
3. Development stage

Appendix 10-1. SPSS: Reasons for uncertainty

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.
2	The median of Feasibility equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.
3	The median of BusinessObjectives equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.359	Retain the null hypothesis.
4	The median of Capability equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
5	The median of MarketPotential equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.011	Reject the null hypothesis.
6	The median of ConsumerBenefit equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.958	Retain the null hypothesis.
7	The median of GutFeeling equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.469	Retain the null hypothesis.
2	The median of Feasibility equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
3	The median of BusinessObjectives equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of Capability equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
5	The median of MarketPotential equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
6	The median of ConsumerBenefit equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.051	Retain the null hypothesis.
7	The median of GutFeeling equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.941	Retain the null hypothesis.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Originality equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.308	Retain the null hypothesis.
2	The median of Feasibility equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
3	The median of BusinessObjectives equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
4	The median of Capability equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.228	Retain the null hypothesis.
5	The median of MarketPotential equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.309	Retain the null hypothesis.
6	The median of ConsumerBenefit equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.864	Retain the null hypothesis.
7	The median of GutFeeling equals 4.80.	One-Sample Wilcoxon Signed Rank Test	.172	Retain the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Novelty / Originality
2. Feasibility
3. Business objectives
4. Fit with capability
5. Market potential
6. Consumer benefit
7. Gut feeling

Appendix 10-2. SPSS: Reasons for uncertainty

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Originality is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of Feasibility is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.317	Retain the null hypothesis.
3	The distribution of BusinessObjectives is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
4	The distribution of Capability is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.005	Reject the null hypothesis.
5	The distribution of MarketPotential is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.315	Retain the null hypothesis.
6	The distribution of ConsumerBenefit is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.052	Retain the null hypothesis.
7	The distribution of GutFeeling is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Novelty / Originality
2. Feasibility
3. Business objectives
4. Fit with capability
5. Market potential
6. Consumer benefit
7. Gut feeling

Kruskal wallis test: pairwise comparisons

Originality/Novelty

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-.836	4.612	-.181	.856	1.000
Engineering-Design	13.080	4.203	3.112	.002	.006
Product Plan-Design	12.244	3.729	3.283	.001	.003

Business Objectives

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-2.269	4.353	-.521	.602	1.000
Design-Product Plan	-16.812	3.863	-4.352	.000	.000
Engineering-Product Plan	-14.543	4.776	-3.045	.002	.007

Capability

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-10.068	3.637	-2.768	.006	.017
Design-Engineering	-10.475	4.099	-2.556	.011	.032
Product Plan-Engineering	.407	4.498	.091	.928	1.000

Gut feeling

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	1.971	4.712	.418	.676	1.000
Product Plan-Design	14.988	3.811	3.933	.000	.000
Engineering-Design	13.017	4.294	3.031	.002	.007

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 11-1. SPSS: Importance of communication between teams for reducing uncertainty

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of communicationP equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.958	Retain the null hypothesis.
2	The median of communicationD equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
3	The median of communicationE equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
4	The median of communicationO equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.358	Retain the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of communicationP equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.297	Retain the null hypothesis.
2	The median of communicationD equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.157	Retain the null hypothesis.
3	The median of communicationE equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.127	Retain the null hypothesis.
4	The median of communicationO equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.020	Reject the null hypothesis.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of communicationP equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.025	Reject the null hypothesis.
2	The median of communicationD equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.860	Retain the null hypothesis.
3	The median of communicationE equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.860	Retain the null hypothesis.
4	The median of communicationO equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Planning team
2. Design team
3. Engineering team
4. Others (Multidisciplinary team)

Appendix 11-2. SPSS: Importance of communication between teams for reducing uncertainty

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of communicationP is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.254	Retain the null hypothesis.
2	The distribution of communicationD is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.004	Reject the null hypothesis.
3	The distribution of communicationE is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.004	Reject the null hypothesis.
4	The distribution of communicationO is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.313	Retain the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Planning team
2. Design team
3. Engineering team
4. Others (Multidisciplinary team)

Kruskal wallis test: pairwise comparisons

Communication with Design team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	8.071	4.039	1.998	.046	.137
Product Plan-Design	10.676	3.266	3.269	.001	.003
Engineering-Design	2.605	3.681	.708	.479	1.000

Communication with Engineer team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	9.918	3.676	2.698	.007	.021
Product Plan-Engineering	13.800	4.545	3.036	.002	.007
Design-Engineering	-3.882	4.142	-.937	.349	1.000

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 12-1. SPSS: Effectiveness of communication between teams for reducing uncertainty

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of communicationP equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.052	Retain the null hypothesis.
2	The median of communicationD equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.011	Reject the null hypothesis.
3	The median of communicationE equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.
4	The median of communicationO equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of communicationP equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
2	The median of communicationD equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.002	Retain the null hypothesis.
3	The median of communicationE equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.
4	The median of communicationO equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of communicationP equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
2	The median of communicationD equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.861	Retain the null hypothesis.
3	The median of communicationE equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.861	Retain the null hypothesis.
4	The median of communicationO equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Planning team
2. Design team
3. Engineering team
4. Others (Multidisciplinary team)

Appendix 12-2. SPSS: Effectiveness of communication between teams for reducing uncertainty

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of communicationP is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
2	The distribution of communicationD is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of communicationE is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.003	Reject the null hypothesis.
4	The distribution of communicationO is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.280	Retain the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Planning team
2. Design team
3. Engineering team
4. Others (Multidisciplinary team)

Kruskal wallis test: pairwise comparisons

Communication with Planning team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	2.147	4.314	.498	.619	1.000
Engineering-Product Plan	-15.050	4.734	-3.179	.001	.004
Design-Product Plan	-12.903	3.828	-3.371	.001	.002

Communication with Design team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	8.700	4.052	2.147	.032	.095
Product Plan-Design	12.818	3.276	3.912	.000	.000
Engineering-Design	4.118	3.692	1.115	.265	.794

Communication with Engineer team

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	9.518	3.815	2.495	.013	.038
Product Plan-Engineering	15.257	4.717	3.234	.001	.004
Design-Engineering	-5.739	4.299	-1.335	.182	.546

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05) * H1 = Dark coloured cell

Appendix 13. SPSS: Overall nature of data use process

Wilcoxon signed rank test: two-related sample - Formal vs Informal process

Test Statistics[a]

Informal-Formal	Planning	Design	Engineer
Z	-1.150[b]	-1.919[b]	-2.232[b]
Asymp. Sig. (2-tailed)	.250	.055	.026

H0: The results between two samples (informal vs formal) are statistically the same
H1: The results between two samples (informal vs formal) are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = bold lined box

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Formal is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.034	Reject the null hypothesis.
2	The distribution of Informal is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.315	Retain the null hypothesis.
3	The distribution of Structured is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.502	Retain the null hypothesis.
4	The distribution of Unstructured is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.981	Retain the null hypothesis.
5	The distribution of Direct is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.390	Retain the null hypothesis.
6	The distribution of Indirect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.003	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Kruskal wallis test: pairwise comparisons

Formal

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	10.214	4.220	2.420	.016	.047
Engineering-Product Plan	-10.564	4.631	-2.281	.023	.068
Design-Product Plan	-.350	3.745	-.093	.926	1.000

Indirect

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	5.782	4.356	1.327	.184	.553
Engineering-Product Plan	-15.429	4.780	-3.228	.001	.004
Design-Product Plan	-9.647	3.866	-2.496	.013	.038

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Formal 2. Informal 3. Structured 4. Unstructured 5. Direct 6. Indirect

Appendix 14-1. SPSS: Overall nature of usage of data- important data

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
2	The median of DesignTrend equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
3	The median of ExistingProblems equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.958	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.012	Reject the null hypothesis.
6	The median of NewTechnology equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.052	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
10	The median of LegalIssue equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
11	The median of Other equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.169	Retain the null hypothesis.
2	The median of DesignTrend equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.569	Retain the null hypothesis.
3	The median of ExistingProblems equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.290	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.
6	The median of NewTechnology equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.553	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
10	The median of LegalIssue equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
11	The median of Other equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.085	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.058	Retain the null hypothesis.
2	The median of DesignTrend equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.088	Retain the null hypothesis.
3	The median of ExistingProblems equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.393	Retain the null hypothesis.
4	The median of ConsumerNeeds equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.393	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.394	Retain the null hypothesis.
6	The median of NewTechnology equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.490	Retain the null hypothesis.
7	The median of NewSocialBehavior equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.490	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.394	Retain the null hypothesis.
9	The median of EnvironmentalEffect equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.125	Retain the null hypothesis.
10	The median of LegalIssue equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.394	Retain the null hypothesis.
11	The median of Other equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.011	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box
1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products
6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect
10. Legal issue 11.Other

Appendix 14-2. SPSS: Overall nature of usage of data- important data

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of MarketTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.256	Retain the null hypothesis.
2	The distribution of DesignTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.018	Reject the null hypothesis.
3	The distribution of ExistingProblems is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.220	Retain the null hypothesis.
4	The distribution of ConsumerNeeds is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.249	Retain the null hypothesis.
5	The distribution of CompetitiveProducts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.390	Retain the null hypothesis.
6	The distribution of NewTechnology is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.068	Retain the null hypothesis.
7	The distribution of NewSocialBehavior is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.241	Retain the null hypothesis.
8	The distribution of FinancialEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.003	Reject the null hypothesis.
9	The distribution of EnvironmentalEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.012	Reject the null hypothesis.
10	The distribution of LegalIssue is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
11	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products
6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect 10. Legal issue 11.Other

Kruskal wallis test: pairwise comparisons

Design Trends

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	3.757	4.607	.816	.415	1.000
Product Plan-Design	10.253	3.726	2.752	.006	.018
Engineering-Design	6.496	4.198	1.547	.122	.365

Other (unrelated data)

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-1.507	4.730	-.319	.750	1.000
Engineering-Design	17.828	4.311	4.136	.000	.000
Product Plan-Design	16.321	3.825	4.266	.000	.000

Financial effect

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-1.412	3.842	-.367	.713	1.000
Design-Engineering	-14.555	4.330	-3.362	.001	.002
Product Plan-Engineering	13.143	4.751	2.766	.006	.017

Environmental effect

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	4.415	3.807	1.160	.246	.739
Product Plan-Engineering	16.721	4.708	3.552	.000	.001
Design-Engineering	-12.307	4.290	-2.869	.004	.012

Legal issues

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-1.174	3.800	-.309	.757	1.000
Design-Engineering	-16.895	4.282	-3.946	.000	.000
Product Plan-Engineering	15.721	4.699	3.346	.001	.002

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 15-1. SPSS: Overall nature of usage of data- effective data

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.039	Reject the null hypothesis.
2	The median of DesignTrend equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
3	The median of ExistingProblems equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.021	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.501	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.328	Retain the null hypothesis.
6	The median of NewTechnology equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.034	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.958	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
10	The median of LegalIssue equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
11	The median of Other equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
2	The median of DesignTrend equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.683	Retain the null hypothesis.
3	The median of ExistingProblems equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
5	The median of CompetitiveProducts equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
6	The median of NewTechnology equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.271	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
10	The median of LegalIssue equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
11	The median of Other equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.132	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
2	The median of DesignTrend equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
3	The median of ExistingProblems equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.488	Retain the null hypothesis.
4	The median of ConsumerNeeds equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.061	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.170	Retain the null hypothesis.
6	The median of NewTechnology equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.061	Retain the null hypothesis.
7	The median of NewSocialBehavior equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
8	The median of FinancialEffect equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
10	The median of LegalIssue equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.062	Retain the null hypothesis.
11	The median of Other equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products
6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect 10. Legal issue 11.Other

Appendix 15-2. SPSS: Overall nature of usage of data- effective data

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of MarketTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.005	Reject the null hypothesis.
2	The distribution of DesignTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.009	Reject the null hypothesis.
3	The distribution of ExistingProblems is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.
4	The distribution of ConsumerNeeds is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.330	Retain the null hypothesis.
5	The distribution of CompetitiveProducts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.019	Reject the null hypothesis.
6	The distribution of NewTechnology is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.259	Retain the null hypothesis.
7	The distribution of NewSocialBehavior is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.051	Retain the null hypothesis.
8	The distribution of FinancialEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.
9	The distribution of EnvironmentalEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
10	The distribution of LegalIssue is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
11	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products
6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect 10. Legal issue 11.Other

Kruskal wallis test: pairwise comparisons

Market Trend

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-4.971	4.045	-1.229	.219	.657
Design-Product Plan	-11.721	3.589	-3.265	.001	.003
Engineering-Product Plan	-6.750	4.439	-1.521	.128	.385

Design Trend

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-.457	4.738	-.096	.923	1.000
Engineering-Design	10.445	4.318	2.419	.016	.047
Product Plan-Design	9.988	3.832	2.607	.009	.027

Existing Problems

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-4.059	3.846	-1.055	.291	.874
Design-Engineering	-13.916	4.334	-3.211	.001	.004
Product Plan-Engineering	9.857	4.756	2.072	.038	.115

Competitive Products

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-7.650	3.843	-1.991	.047	.140
Design-Engineering	-10.929	4.331	-2.524	.012	.035
Product Plan-Engineering	3.279	4.752	.690	.490	1.000

Financial Effects

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-2.821	3.860	-.731	.465	1.000
Design-Engineering	-15.256	4.350	-3.507	.000	.001
Product Plan-Engineering	12.436	4.774	2.605	.009	.028

Environmental Effects

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	1.182	3.778	.313	.754	1.000
Product Plan-Engineering	13.157	4.672	2.816	.005	.015
Design-Engineering	-11.975	4.257	-2.813	.005	.015

Legal Issues

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-.565	3.807	-.148	.882	1.000
Design-Engineering	-15.050	4.290	-3.508	.000	.001
Product Plan-Engineering	14.486	4.708	3.077	.002	.006

Other

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	.000	4.565	.000	1.000	1.000
Engineering-Design	17.000	4.160	4.087	.000	.000
Product Plan-Design	17.000	3.692	4.605	.000	.000

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 16-1. SPSS: Data frequently used in the focus stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.782	Retain the null hypothesis.
2	The median of DesignTrend equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
3	The median of ExistingProblems equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.100	Retain the null hypothesis.
4	The median of ConsumerNeeds equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.782	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.223	Retain the null hypothesis.
6	The median of NewTechnology equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.007	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.50.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.003	Reject the null hypothesis.
10	The median of LegalIssue equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
11	The median of Other equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.050	Retain the null hypothesis.
2	The median of DesignTrend equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.127	Retain the null hypothesis.
3	The median of ExistingProblems equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.
5	The median of CompetitiveProducts equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.003	Reject the null hypothesis.
6	The median of NewTechnology equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.941	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
10	The median of LegalIssue equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
11	The median of Other equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.025	Reject the null hypothesis.
2	The median of DesignTrend equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.062	Retain the null hypothesis.
3	The median of ExistingProblems equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.860	Retain the null hypothesis.
4	The median of ConsumerNeeds equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.060	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.861	Retain the null hypothesis.
6	The median of NewTechnology equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.206	Retain the null hypothesis.
7	The median of NewSocialBehavior equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
8	The median of FinancialEffect equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.
10	The median of LegalIssue equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
11	The median of Other equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products 6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect 10. Legal issue 11.Other

Appendix 16-2. SPSS: Data frequently used in the focus stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of MarketTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.140	Retain the null hypothesis.
2	The distribution of DesignTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.002	Reject the null hypothesis.
3	The distribution of ExistingProblems is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.067	Retain the null hypothesis.
4	The distribution of ConsumerNeeds is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.238	Retain the null hypothesis.
5	The distribution of CompetitiveProducts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.126	Retain the null hypothesis.
6	The distribution of NewTechnology is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.002	Reject the null hypothesis.
7	The distribution of NewSocialBehavior is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
8	The distribution of FinancialEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.031	Reject the null hypothesis.
9	The distribution of EnvironmentalEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.821	Retain the null hypothesis.
10	The distribution of LegalIssue is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.121	Retain the null hypothesis.
11	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products 6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect 10. Legal issue 11.Other

Kruskal wallis test: pairwise comparisons

Design Trend

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	2.007	4.731	.424	.671	1.000
Product Plan-Design	12.474	3.826	3.260	.001	.003
Engineering-Design	10.466	4.312	2.427	.015	.046

New Technology Opportunity

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	1.488	3.827	.389	.697	1.000
Product Plan-Engineering	15.329	4.732	3.239	.001	.004
Design-Engineering	-13.840	4.312	-3.209	.001	.004

New Social Behavior

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-12.964	4.511	-2.874	.004	.012
Engineering-Design	14.803	4.110	3.601	.000	.001
Product Plan-Design	1.838	3.648	.504	.614	1.000

Other (Data unrelated to NPD theme)

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	.000	4.565	.000	1.000	1.000
Engineering-Design	17.000	4.160	4.086	.000	.000
Product Plan-Design	17.000	3.692	4.605	.000	.000

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 17-1. SPSS: Data frequently used in the direction stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.012	Reject the null hypothesis.
2	The median of DesignTrend equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.
3	The median of ExistingProblems equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.011	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.358	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.025	Reject the null hypothesis.
6	The median of NewTechnology equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.497	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
10	The median of LegalIssue equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
11	The median of Other equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
2	The median of DesignTrend equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.648	Retain the null hypothesis.
3	The median of ExistingProblems equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.064	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.
6	The median of NewTechnology equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.494	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
10	The median of LegalIssue equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
11	The median of Other equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.396	Retain the null hypothesis.
2	The median of DesignTrend equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.062	Retain the null hypothesis.
3	The median of ExistingProblems equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
4	The median of ConsumerNeeds equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.734	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.864	Retain the null hypothesis.
6	The median of NewTechnology equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
7	The median of NewSocialBehavior equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.864	Retain the null hypothesis.
8	The median of FinancialEffect equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
9	The median of EnvironmentalEffect equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
10	The median of LegalIssue equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.232	Retain the null hypothesis.
11	The median of Other equals 4.40.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products 6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect 10. Legal issue 11.Other

Appendix 17-2. SPSS: Data frequently used in the direction stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of MarketTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.536	Retain the null hypothesis.
2	The distribution of DesignTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of ExistingProblems is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.175	Retain the null hypothesis.
4	The distribution of ConsumerNeeds is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.027	Reject the null hypothesis.
5	The distribution of CompetitiveProducts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.045	Reject the null hypothesis.
6	The distribution of NewTechnology is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.013	Reject the null hypothesis.
7	The distribution of NewSocialBehavior is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.063	Retain the null hypothesis.
8	The distribution of FinancialEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
9	The distribution of EnvironmentalEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.051	Retain the null hypothesis.
10	The distribution of LegalIssue is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.045	Reject the null hypothesis.
11	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products 6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect 10. Legal issue 11.Other

Kruskal wallis test: pairwise comparisons

Design Trend

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-2.464	4.770	-.517	.605	1.000
Engineering-Design	14.979	4.347	3.446	.001	.002
Product Plan-Design	12.515	3.857	3.244	.001	.004

Other (Data unrelated to NPD theme)

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	.000	4.508	.000	1.000	1.000
Engineering-Design	16.000	4.108	3.895	.000	.000
Product Plan-Design	16.000	3.646	4.389	.000	.000

Consumer Needs

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	3.815	4.139	.922	.357	1.000
Engineering-Product Plan	-11.486	4.542	-2.529	.011	.034
Design-Product Plan	-7.671	3.673	-2.088	.037	.110

New Technology Opportunity

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	4.074	3.656	1.114	.265	.795
Product Plan-Engineering	13.179	4.520	2.915	.004	.011
Design-Engineering	-9.105	4.119	-2.210	.027	.081

Financial Effect

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-7.344	3.866	-1.900	.057	.172
Design-Engineering	-12.794	4.356	-2.937	.003	.010
Product Plan-Engineering	5.450	4.780	1.140	.254	.763

Legal issues

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-4.550	3.782	-1.203	.229	.687
Design-Engineering	-10.500	4.262	-2.464	.014	.041
Product Plan-Engineering	5.950	4.677	1.272	.203	.610

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 18-1. SPSS: Data frequently used in the development stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
2	The median of DesignTrend equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.328	Retain the null hypothesis.
3	The median of ExistingProblems equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.009	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.501	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.329	Retain the null hypothesis.
6	The median of NewTechnology equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.011	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.436	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
10	The median of LegalIssue equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
11	The median of Other equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
2	The median of DesignTrend equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.608	Retain the null hypothesis.
3	The median of ExistingProblems equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
5	The median of CompetitiveProducts equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
6	The median of NewTechnology equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
7	The median of NewSocialBehavior equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.052	Retain the null hypothesis.
8	The median of FinancialEffect equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
9	The median of EnvironmentalEffect equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
10	The median of LegalIssue equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
11	The median of Other equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.129	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of MarketTrend equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
2	The median of DesignTrend equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.127	Retain the null hypothesis.
3	The median of ExistingProblems equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.
4	The median of ConsumerNeeds equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
5	The median of CompetitiveProducts equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.609	Retain the null hypothesis.
6	The median of NewTechnology equals 4.90.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
7	The median of NewSocialBehavior equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.062	Retain the null hypothesis.
8	The median of FinancialEffect equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.609	Retain the null hypothesis.
9	The median of EnvironmentalEffect equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.125	Retain the null hypothesis.
10	The median of LegalIssue equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.495	Retain the null hypothesis.
11	The median of Other equals 4.90.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Market trends 2. Design trends 3. Existing problem
4. Consumer needs 5. Competitive products
6. New technology opportunities 7. New social culture and behavior 8. Financial effect 9. Environmental effect 10. Legal issue 11.Other

Appendix 18-2. SPSS: Data frequently used in the development stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of MarketTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.904	Retain the null hypothesis.
2	The distribution of DesignTrend is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of ExistingProblems is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.838	Retain the null hypothesis.
4	The distribution of ConsumerNeeds is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.019	Reject the null hypothesis.
5	The distribution of CompetitiveProducts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.524	Retain the null hypothesis.
6	The distribution of NewTechnology is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.125	Retain the null hypothesis.
7	The distribution of NewSocialBehavior is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.012	Reject the null hypothesis.
8	The distribution of FinancialEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
9	The distribution of EnvironmentalEffect is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.033	Reject the null hypothesis.
10	The distribution of LegalIssue is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
11	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Market trends 2. Design trends 3. Existing problem 4. Consumer needs 5. Competitive products 6. New technology opportunities
7. New social culture and behavior 8. Financial effect 9. Environmental effect 10. Legal issue 11.Other

Kruskal wallis test: pairwise comparisons

Design Trend

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-6.343	4.422	-1.434	.151	.454
Engineering-Design	15.555	4.030	3.860	.000	.000
Product Plan-Design	9.212	3.576	2.576	.010	.030

Consumer Needs

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-5.580	4.316	-1.293	.196	.588
Design-Product Plan	-10.694	3.830	-2.792	.005	.016
Engineering-Product Plan	-5.114	4.736	-1.080	.280	.841

New Social Behavior

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	10.815	4.267	2.535	.011	.034
Engineering-Product Plan	-13.186	4.682	-2.816	.005	.015
Design-Product Plan	-2.371	3.786	-.626	.531	1.000

Financial Effect

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-7.315	3.771	-1.940	.052	.157
Design-Engineering	-17.550	4.250	-4.130	.000	.000
Product Plan-Engineering	10.236	4.663	2.195	.028	.085

Environmental Effect

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-3.794	3.607	-1.052	.293	.879
Design-Engineering	-10.580	4.065	-2.603	.009	.028
Product Plan-Engineering	6.786	4.461	1.521	.128	.385

Legal Issue

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-.624	3.807	-.164	.870	1.000
Design-Engineering	-15.252	4.290	-3.555	.000	.001
Product Plan-Engineering	14.629	4.708	3.107	.002	.006

Other (Data unrelated to NPD theme)

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	.000	4.537	.000	1.000	1.000
Engineering-Design	17.000	4.135	4.111	.000	.000
Product Plan-Design	17.000	3.669	4.633	.000	.000

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 19-1. SPSS: Overall nature of usage of data – important data resource

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.958	Retain the null hypothesis.
2	The median of ExternalExperts equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.194	Retain the null hypothesis.
3	The median of InternalDatabase equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.007	Reject the null hypothesis.
6	The median of JournalArticle equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.012	Reject the null hypothesis.
7	The median of Other equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.20.	One-Sample Wilcoxon Signed Rank Test	.680	Retain the null hypothesis.
2	The median of ExternalExperts equals 5.20.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
3	The median of InternalDatabase equals 5.20.	One-Sample Wilcoxon Signed Rank Test	.018	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.20.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.20.	One-Sample Wilcoxon Signed Rank Test	.680	Retain the null hypothesis.
6	The median of JournalArticle equals 5.20.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
7	The median of Other equals 5.20.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.394	Retain the null hypothesis.
2	The median of ExternalExperts equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
3	The median of InternalDatabase equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
4	The median of ExternalDatabase equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.041	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.125	Retain the null hypothesis.
6	The median of JournalArticle equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.041	Reject the null hypothesis.
7	The median of Other equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Appendix 19-2. SPSS: Overall nature of usage of data – important data resource

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of InternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.286	Retain the null hypothesis.
2	The distribution of ExternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.019	Reject the null hypothesis.
3	The distribution of InternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.434	Retain the null hypothesis.
4	The distribution of ExternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.261	Retain the null hypothesis.
5	The distribution of WebSearchingEngine is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.022	Reject the null hypothesis.
6	The distribution of JournalArticle is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.400	Retain the null hypothesis.
7	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.112	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Kruskal wallis test: pairwise comparisons

External experts

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	2.668	4.288	.622	.534	1.000
Engineering-Product Plan	-11.736	4.705	-2.494	.013	.038
Design-Product Plan	-9.068	3.805	-2.383	.017	.052

Web Searching Engine

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	1.507	4.730	.319	.750	1.000
Product Plan-Design	9.679	3.825	2.530	.011	.034
Engineering-Design	8.172	4.311	1.896	.058	.174

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 20-1. SPSS: Overall nature of usage of data – effective data resource

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.038	Reject the null hypothesis.
2	The median of ExternalExperts equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.782	Retain the null hypothesis.
3	The median of InternalDatabase equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.039	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.100	Retain the null hypothesis.
6	The median of JournalArticle equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.025	Reject the null hypothesis.
7	The median of Other equals 5.50.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
2	The median of ExternalExperts equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
3	The median of InternalDatabase equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.468	Retain the null hypothesis.
6	The median of JournalArticle equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.052	Retain the null hypothesis.
7	The median of Other equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 4.70.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
2	The median of ExternalExperts equals 4.70.	One-Sample Wilcoxon Signed Rank Test	.734	Retain the null hypothesis.
3	The median of InternalDatabase equals 4.70.	One-Sample Wilcoxon Signed Rank Test	.731	Retain the null hypothesis.
4	The median of ExternalDatabase equals 4.70.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
5	The median of WebSearchingEngine equals 4.70.	One-Sample Wilcoxon Signed Rank Test	.172	Retain the null hypothesis.
6	The median of JournalArticle equals 4.70.	One-Sample Wilcoxon Signed Rank Test	.062	Retain the null hypothesis.
7	The median of Other equals 4.70.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Appendix 20-2. SPSS: Overall nature of usage of data – effective data resource

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of InternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.002	Reject the null hypothesis.
2	The distribution of ExternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.011	Reject the null hypothesis.
3	The distribution of InternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.032	Reject the null hypothesis.
4	The distribution of ExternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.959	Retain the null hypothesis.
5	The distribution of WebSearchingEngine is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.
6	The distribution of JournalArticle is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.016	Reject the null hypothesis.
7	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.112	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Kruskal wallis test: pairwise comparisons

Internal experts

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	4.971	4.262	1.166	.244	.731
Engineering-Product Plan	-15.350	4.677	-3.282	.001	.003
Design-Product Plan	-10.379	3.782	-2.744	.006	.018

External experts

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-4.294	4.347	-.988	.323	.970
Design-Product Plan	-11.594	3.857	-3.006	.003	.008
Engineering-Product Plan	-7.300	4.770	-1.530	.126	.378

Internal database

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	1.671	3.791	.441	.659	1.000
Product Plan-Engineering	11.486	4.688	2.450	.014	.043
Design-Engineering	-9.815	4.272	-2.297	.022	.065

Web Searching Engine

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-3.821	4.477	-.854	.393	1.000
Engineering-Design	11.895	4.080	2.915	.004	.011
Product Plan-Design	8.074	3.621	2.230	.026	.077

Journal and article

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-3.321	4.740	-.701	.483	1.000
Engineering-Design	11.189	4.319	2.591	.010	.029
Product Plan-Design	7.868	3.833	2.053	.040	.120

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 21-1. SPSS: Data resources frequently used in the focus stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.958	Retain the null hypothesis.
2	The median of ExternalExperts equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.195	Retain the null hypothesis.
3	The median of InternalDatabase equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.071	Retain the null hypothesis.
5	The median of WebSearchingEngine equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.958	Retain the null hypothesis.
6	The median of JournalArticle equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
7	The median of Other equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
2	The median of ExternalExperts equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
3	The median of InternalDatabase equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.149	Retain the null hypothesis.
6	The median of JournalArticle equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.003	Reject the null hypothesis.
7	The median of Other equals 5.60.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
2	The median of ExternalExperts equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.088	Retain the null hypothesis.
3	The median of InternalDatabase equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.394	Retain the null hypothesis.
4	The median of ExternalDatabase equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.234	Retain the null hypothesis.
5	The median of WebSearchingEngine equals 5.30.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
6	The median of JournalArticle equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
7	The median of Other equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Appendix 21-2. SPSS: Data resources frequently used in the focus stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of InternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
2	The distribution of ExternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.033	Reject the null hypothesis.
3	The distribution of InternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.071	Retain the null hypothesis.
4	The distribution of ExternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.688	Retain the null hypothesis.
5	The distribution of WebSearchingEngine is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.391	Retain the null hypothesis.
6	The distribution of JournalArticle is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.020	Reject the null hypothesis.
7	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.203	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Kruskal wallis test: pairwise comparisons

Internal experts

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	5.374	4.271	1.258	.208	.625
Engineering-Product Plan	-13.936	4.687	-2.973	.003	.009
Design-Product Plan	-8.562	3.790	-2.259	.024	.072

External experts

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-.714	4.350	-.164	.870	1.000
Design-Product Plan	-9.700	3.860	-2.513	.012	.036
Engineering-Product Plan	-8.986	4.773	-1.882	.060	.179

Journal and Article

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-2.279	4.773	-.477	.633	1.000
Engineering-Design	10.517	4.350	2.418	.016	.047
Product Plan-Design	8.238	3.860	2.134	.033	.098

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 22-1. SPSS: Data resources frequently used in the direction stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.052	Retain the null hypothesis.
2	The median of ExternalExperts equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.026	Reject the null hypothesis.
3	The median of InternalDatabase equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
6	The median of JournalArticle equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
7	The median of Other equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.
2	The median of ExternalExperts equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
3	The median of InternalDatabase equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.518	Retain the null hypothesis.
6	The median of JournalArticle equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.
7	The median of Other equals 5.10.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 3.90.	One-Sample Wilcoxon Signed Rank Test	.493	Retain the null hypothesis.
2	The median of ExternalExperts equals 3.90.	One-Sample Wilcoxon Signed Rank Test	.173	Retain the null hypothesis.
3	The median of InternalDatabase equals 3.90.	One-Sample Wilcoxon Signed Rank Test	.733	Retain the null hypothesis.
4	The median of ExternalDatabase equals 3.90.	One-Sample Wilcoxon Signed Rank Test	.609	Retain the null hypothesis.
5	The median of WebSearchingEngine equals 3.90.	One-Sample Wilcoxon Signed Rank Test	.488	Retain the null hypothesis.
6	The median of JournalArticle equals 3.90.	One-Sample Wilcoxon Signed Rank Test	.015	Reject the null hypothesis.
7	The median of Other equals 3.90.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Appendix 22-2. SPSS: Data resources frequently used in the direction stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of InternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of ExternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.015	Reject the null hypothesis.
3	The distribution of InternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.837	Retain the null hypothesis.
4	The distribution of ExternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.667	Retain the null hypothesis.
5	The distribution of WebSearchingEngine is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
6	The distribution of JournalArticle is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.
7	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.357	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Kruskal wallis test: pairwise comparisons

Internal experts

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	3.303	4.330	.763	.446	1.000
Engineering-Product Plan	-17.214	4.751	-3.623	.000	.001
Design-Product Plan	-13.912	3.842	-3.621	.000	.001

External experts

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	3.761	4.365	.861	.389	1.000
Engineering-Product Plan	-12.793	4.790	-2.671	.008	.023
Design-Product Plan	-9.032	3.874	-2.332	.020	.059

Web searching Engine

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-1.357	4.752	-.286	.775	1.000
Engineering-Design	13.916	4.331	3.213	.001	.004
Product Plan-Design	12.559	3.843	3.268	.001	.003

Journal and Article

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-4.271	4.757	-.898	.369	1.000
Engineering-Design	12.630	4.335	2.914	.004	.011
Product Plan-Design	8.359	3.847	2.173	.030	.089

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 23-1. SPSS: Data resources frequently used in the development stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.795	Retain the null hypothesis.
2	The median of ExternalExperts equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.021	Reject the null hypothesis.
3	The median of InternalDatabase equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.012	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.036	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.437	Retain the null hypothesis.
6	The median of JournalArticle equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
7	The median of Other equals 5.30.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
2	The median of ExternalExperts equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
3	The median of InternalDatabase equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of ExternalDatabase equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
5	The median of WebSearchingEngine equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.157	Retain the null hypothesis.
6	The median of JournalArticle equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
7	The median of Other equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of InternalExperts equals 4.10.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
2	The median of ExternalExperts equals 4.10.	One-Sample Wilcoxon Signed Rank Test	.394	Retain the null hypothesis.
3	The median of InternalDatabase equals 4.10.	One-Sample Wilcoxon Signed Rank Test	.605	Retain the null hypothesis.
4	The median of ExternalDatabase equals 4.10.	One-Sample Wilcoxon Signed Rank Test	.864	Retain the null hypothesis.
5	The median of WebSearchingEngine equals 4.10.	One-Sample Wilcoxon Signed Rank Test	.606	Retain the null hypothesis.
6	The median of JournalArticle equals 4.10.	One-Sample Wilcoxon Signed Rank Test	.061	Retain the null hypothesis.
7	The median of Other equals 4.10.	One-Sample Wilcoxon Signed Rank Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Appendix 23-2. SPSS: Data resources frequently used in the development stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of InternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of ExternalExperts is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.080	Retain the null hypothesis.
3	The distribution of InternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.342	Retain the null hypothesis.
4	The distribution of ExternalDatabase is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.938	Retain the null hypothesis.
5	The distribution of WebSearchingEngine is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
6	The distribution of JournalArticle is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
7	The distribution of Other is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.112	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Internal resource expert 2.External resource expert, 3.Internal database site, 4.External database site, 5.Web search engine site, 6.Journal or article, 7. Other

Kruskal wallis test: pairwise comparisons

Internal experts

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	2.975	4.374	.680	.496	1.000
Engineering-Product Plan	-18.257	4.800	-3.804	.000	.000
Design-Product Plan	-15.282	3.882	-3.937	.000	.000

Web searching Engine

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-6.507	4.263	-1.526	.127	.381
Engineering-Design	13.887	3.885	3.574	.000	.001
Product Plan-Design	7.379	3.448	2.141	.032	.097

Journal and Article

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	3.143	4.802	.655	.513	1.000
Product Plan-Design	15.706	3.883	4.045	.000	.000
Engineering-Design	12.563	4.376	2.871	.004	.012

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 24-1. SPSS: Overall nature of usage of data – important data formats

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.026	Reject the null hypothesis.
2	The median of Text equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.958	Retain the null hypothesis.
3	The median of Video equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
4	The median of RealSample equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
5	The median of VerbalExplanation equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.317	Retain the null hypothesis.
2	The median of Text equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
3	The median of Video equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.007	Reject the null hypothesis.
4	The median of RealSample equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.002	Reject the null hypothesis.
5	The median of VerbalExplanation equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.860	Retain the null hypothesis.
2	The median of Text equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.490	Retain the null hypothesis.
3	The median of Video equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.060	Retain the null hypothesis.
4	The median of RealSample equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.860	Retain the null hypothesis.
5	The median of VerbalExplanation equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Appendix 24-2. SPSS: Overall nature of usage of data – important data formats

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Image is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.002	Reject the null hypothesis.
2	The distribution of Text is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.022	Reject the null hypothesis.
3	The distribution of Video is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.348	Retain the null hypothesis.
4	The distribution of RealSample is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
5	The distribution of VerbalExplanation is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.920	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Kruskal wallis test: pairwise comparisons

Image

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	7.629	3.912	1.950	.051	.154
Product Plan-Design	11.259	3.164	3.558	.000	.001
Engineering-Design	3.630	3.565	1.018	.309	.926

Text

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-5.618	4.170	-1.347	.178	.534
Design-Product Plan	-10.068	3.701	-2.720	.007	.020
Engineering-Product Plan	-4.450	4.576	-.972	.331	.992

Real sample

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	5.129	3.835	1.338	.181	.543
Product Plan-Engineering	14.743	4.742	3.109	.002	.006
Design-Engineering	-9.613	4.321	-2.225	.026	.078

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 25-1. SPSS: Overall nature of usage of data – effective data formats

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.501	Retain the null hypothesis.
2	The median of Text equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.566	Retain the null hypothesis.
3	The median of Video equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
4	The median of RealSample equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
5	The median of VerbalExplanation equals 5.40.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.157	Retain the null hypothesis.
2	The median of Text equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
3	The median of Video equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.010	Reject the null hypothesis.
4	The median of RealSample equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
5	The median of VerbalExplanation equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.046	Reject the null hypothesis.
2	The median of Text equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.024	Reject the null hypothesis.
3	The median of Video equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.026	Reject the null hypothesis.
4	The median of RealSample equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.317	Retain the null hypothesis.
5	The median of VerbalExplanation equals 5.90.	One-Sample Wilcoxon Signed Rank Test	.041	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Appendix 25-2. SPSS: Overall nature of usage of data – effective data formats

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Image is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.005	Reject the null hypothesis.
2	The distribution of Text is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.016	Reject the null hypothesis.
3	The distribution of Video is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.049	Reject the null hypothesis.
4	The distribution of RealSample is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
5	The distribution of VerbalExplanation is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.142	Retain the null hypothesis.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Kruskal wallis test: pairwise comparisons

Image

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	3.357	4.196	.800	.424	1.000
Product Plan-Design	10.618	3.393	3.129	.002	.005
Engineering-Design	7.261	3.823	1.899	.058	.173

Text

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Design	.345	4.305	.080	.936	1.000
Engineering-Product Plan	-10.586	4.724	-2.241	.025	.075
Design-Product Plan	-10.241	3.821	-2.680	.007	.022

Real sample

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	4.971	3.813	1.304	.192	.577
Product Plan-Engineering	14.643	4.715	3.106	.002	.006
Design-Engineering	-9.672	4.296	-2.251	.024	.073

Video

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Engineering	2.014	4.719	.427	.670	1.000
Product Plan-Design	8.771	3.817	2.298	.022	.065
Engineering-Design	6.756	4.301	1.571	.116	.349

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 26-1. SPSS: Data formats frequently used in the focus stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.063	Retain the null hypothesis.
2	The median of Text equals 6.00.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
3	The median of Video equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
4	The median of RealSample equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.
5	The median of VerbalExplanation equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.006	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.149	Retain the null hypothesis.
2	The median of Text equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.296	Retain the null hypothesis.
3	The median of Video equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of RealSample equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
5	The median of VerbalExplanation equals 5.80.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.102	Retain the null hypothesis.
2	The median of Text equals 6.00.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
3	The median of Video equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
4	The median of RealSample equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.
5	The median of VerbalExplanation equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Appendix 26-2. SPSS: Data formats frequently used in the focus stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Image is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.322	Retain the null hypothesis.
2	The distribution of Text is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.015	Reject the null hypothesis.
3	The distribution of Video is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.362	Retain the null hypothesis.
4	The distribution of RealSample is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.271	Retain the null hypothesis.
5	The distribution of VerbalExplanation is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.117	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Kruskal wallis test: pairwise comparisons

Text

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-7.000	3.154	-2.220	.026	.079
Design-Product Plan	-7.000	2.799	-2.501	.012	.037
Engineering-Product Plan	.000	3.461	.000	1.000	1.000

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Appendix 27-1. SPSS: Data formats frequently used in the direction stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
2	The median of Text equals 6.00.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
3	The median of Video equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.007	Reject the null hypothesis.
4	The median of RealSample equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
5	The median of VerbalExplanation equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.941	Retain the null hypothesis.
2	The median of Text equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.020	Reject the null hypothesis.
3	The median of Video equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of RealSample equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
5	The median of VerbalExplanation equals 5.70.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.157	Retain the null hypothesis.
2	The median of Text equals 6.00.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
3	The median of Video equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.016	Reject the null hypothesis.
4	The median of RealSample equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
5	The median of VerbalExplanation equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.024	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Appendix 27-2. SPSS: Data formats frequently used in the direction stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Image is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.011	Reject the null hypothesis.
2	The distribution of Text is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
3	The distribution of Video is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.311	Retain the null hypothesis.
4	The distribution of RealSample is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.546	Retain the null hypothesis.
5	The distribution of VerbalExplanation is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.023	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Kruskal wallis test: pairwise comparisons

Image

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	9.882	3.511	2.815	.005	.015
Product Plan-Engineering	10.000	4.342	2.303	.021	.064
Design-Engineering	-.118	3.957	-.030	.976	1.000

Text

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-10.000	3.591	-2.785	.005	.016
Design-Product Plan	-10.000	3.187	-3.138	.002	.005
Engineering-Product Plan	.000	3.941	.000	1.000	1.000

Speaking (Explanation)

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	8.218	3.817	2.153	.031	.094
Product Plan-Engineering	12.100	4.720	2.564	.010	.031
Design-Engineering	-3.882	4.301	-.903	.367	1.000

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 28-1. SPSS: Data formats frequently used in the development stage

Wilcoxon signed rank test: one sample nonparametric test

Planning team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.
2	The median of Text equals 6.00.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
3	The median of Video equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.007	Reject the null hypothesis.
4	The median of RealSample equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.005	Reject the null hypothesis.
5	The median of VerbalExplanation equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.004	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Design team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 6.00.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
2	The median of Text equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
3	The median of Video equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.
4	The median of RealSample equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
5	The median of VerbalExplanation equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Engineering team

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Image equals 6.00.	One-Sample Wilcoxon Signed Rank Test	1.000	Retain the null hypothesis.
2	The median of Text equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.317	Retain the null hypothesis.
3	The median of Video equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.017	Reject the null hypothesis.
4	The median of RealSample equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.039	Reject the null hypothesis.
5	The median of VerbalExplanation equals 6.00.	One-Sample Wilcoxon Signed Rank Test	.317	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results between sample examples and the highest example are statistically the same
H1: The results between sample examples and the highest example are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell
* Highest example = bold lined box

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Appendix 28-2. SPSS: Data formats frequently used in the development stage

Kruskal wallis test: overall

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Image is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of Text is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of Video is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.005	Reject the null hypothesis.
4	The distribution of RealSample is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.048	Reject the null hypothesis.
5	The distribution of VerbalExplanation is the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

H0: The results among all sample examples are statistically the same
H1: The results among all sample examples are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

1. Image, 2. Text, 3. Video, 4. Real-sample, 5. Explanation

Kruskal wallis test: pairwise comparisons

Image

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	10.200	2.622	3.891	.000	.000
Product Plan-Engineering	10.200	3.242	3.146	.002	.005
Design-Engineering	.000	2.954	.000	1.000	1.000

Text

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Engineering	-15.084	4.140	-3.643	.000	.001
Design-Product Plan	-16.441	3.674	-4.475	.000	.000
Engineering-Product Plan	-1.357	4.543	-.299	.765	1.000

Video

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Engineering-Product Plan	-4.071	4.765	-.854	.393	1.000
Engineering-Design	12.748	4.342	2.936	.003	.010
Product Plan-Design	8.676	3.854	2.252	.024	.073

Real Sample

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Product Plan-Design	1.391	3.877	.359	.720	1.000
Product Plan-Engineering	10.950	4.794	2.284	.022	.067
Design-Engineering	-9.559	4.369	-2.188	.029	.086

Speaking (Explanation)

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Design-Product Plan	-.785	3.883	-.202	.840	1.000
Design-Engineering	-14.592	4.375	-3.335	.001	.003
Product Plan-Engineering	13.807	4.801	2.876	.004	.012

H0: The results between two sample groups are statistically the same
H1: The results between two sample groups are statistically different
(with a = 0.05, confidence level 95%, Accept H0 if p>0.05, Reject H0 and Accept H1 if p<0.05)
* H1 = Dark coloured cell

Appendix 29. Interview Questionnaire

Title of the proposed investigation: Design-Driven Innovation:

The Role of Stimulus Data in Improving Idea Quality when Generating and Developing Ideas in New Product Development (NPD) Processes

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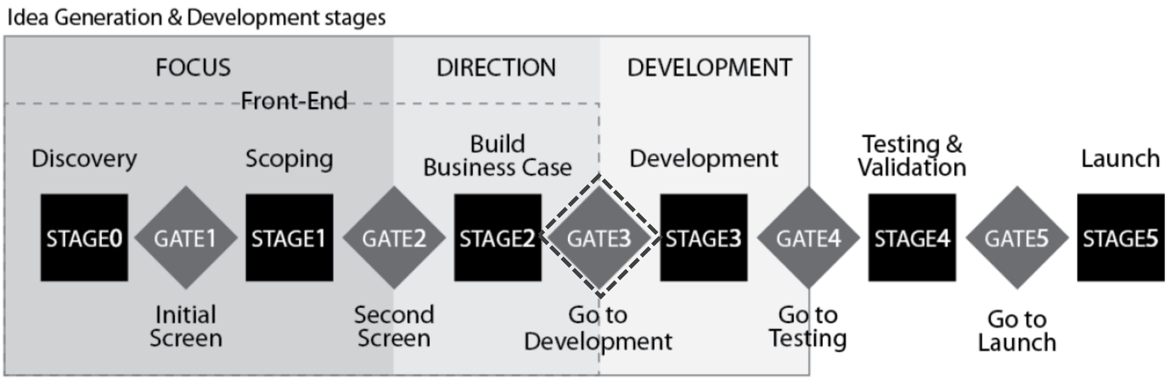
Research Background

This research and questionnaire are formulated based on the New Product Development(NPD) model processes (Cooper, 1990; Ulrich & Eppinger, 2012). The specific focus of the study is on the idea generation (front-end) and development stages of NPD, as the early consideration of new product concept is critical to the success or failure of design products (Argument et al.,1998; Bhamra, 2004; MacMillan et al., 2001; Poole & Simon,1997; Sandstrom & Tingstrom, 2008).

This research set a range of 'Idea generation and development stages' as below.



[Key Actions]

Range	Corresponding action
Focus	Planning project mission: Pre-work designed to discover and uncover business opportunities and generate new ideas. Quick, inexpensive preliminary investigation and scoping of the project (largely desk research).
Direction	Identifying targets: Detailed investigation involving primary research (customer, market, and technical) leading to a business case that includes product and project definition, project justification, and proposed plan for development.
Development	Developing product specification: The actual detailed design and development of the new product and the design of the operations or production process required for eventual full-scale production.

(Cooper, 1990; Ulrich & Eppinger, 2012)

SECTION A. IDEAS AND THE NATURE OF PROCESS

A.1. When generating and developing new ideas (see front interview questionnaire page; focus, direction, and development stages), how long does it typically take?

A.2. When developing a New Product Concept, how important is the idea generation stage? and Why?

Scale: . 1. Never <-------> 6.Very important

1	2	3	4	5	6

A.3. When generating ideas, what is your typical focus for new ideas? and Why?

Scale: 1. Never <-------> 6. Always

Quantity of ideas	1	2	3	4	5	6
Quality of ideas	1	2	3	4	5	6
Others	1	2	3	4	5	6

A.4.How would you describe the nature of your idea generation process? and Why?

Scale: 1. Never <-------> 6. Always

a. Formal process	1	2	3	4	5	6
b. Informal process	1	2	3	4	5	6
c. Structured process	1	2	3	4	5	6
d. Unstructured process	1	2	3	4	5	6
e. Individual Based process	1	2	3	4	5	6
f. Team Based process	1	2	3	4	5	6

A.5. Please answer the questions below about 'Defining Quality of Ideas'. and Why?

Scale: Scale: 1. Never <-------> 6. Always

How important are the following factors in defining the quality of ideas?

How effective are the following factors in defining the quality of ideas?

How often do you use following factors to define the quality of ideas?

	Importance						**Effectiveness**						**Frequency**					
a. Originality/ Novelty	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
b. Feasibility	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
c. Strategic alignment to business objectives	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
d. Fit with capability	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
e. Market potential/ Value	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
f. Consumer Benefit	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
g. Gut feeling	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
h. Other	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6

SECTION B. INITIATION / PEOPLE INVOLVEMENT

B.1. When initiating a New Product Development, which of the following factors are the typical reason for starting a project? and Why ? (What is the starting-point)

Scale: 1. Never <-------> 6. Always

a. Changing Market Trends	1	2	3	4	5	6
b. Changing Design Trends	1	2	3	4	5	6
c. Existing Problems	1	2	3	4	5	6
d. Consumer Needs	1	2	3	4	5	6
e. Competitive Products	1	2	3	4	5	6
f. New Technology Opportunities	1	2	3	4	5	6
g. New Social Culture and Behavior	1	2	3	4	5	6
h. Financial Effect	1	2	3	4	5	6
I. Environmental Effect	1	2	3	4	5	6
j. Legal Issue	1	2	3	4	5	6
k. Other	1	2	3	4	5	6

B.2. Please answer the questions below about ' Team Involvement in Idea Generation', and Why?

Scale: 1. Never <-------> 6. Very important/effective

	When generating ideas, which of the following teams are typically most important?						When generating ideas, which of the following teams are typically most effective?					
	Importance						**Effectiveness**					
a. Product Planning Team	1	2	3	4	5	6	1	2	3	4	5	6
b. Design Team	1	2	3	4	5	6	1	2	3	4	5	6
c. Engineer Team	1	2	3	4	5	6	1	2	3	4	5	6
d. Other (Multidisciplinary)	1	2	3	4	5	6	1	2	3	4	5	6

B.3. When generating ideas, which of the following teams are typically involved in each phase?

Scale: 1. Never <-------> 6. Always

	FOCUS						***DIRECTION***						***DEVELOPMENT***					
a. Product Planning Team	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
b. Design Team	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
c. Engineer Team	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
d. Other (Multidisciplinary)	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6

And What are the main roles of your team in each stage?

SECTION C. UNCERTAINTY

C.1. During idea generation and development stages, how much do you typically experience uncertainty in each phase? and Why?

Scale: 1. Never <-------> 6. Always

FOCUS						DIRECTION						DEVELOPMENT					
1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6

C.2. When generating and developing new ideas, which of the following factors cause uncertainty? and Why?

Scale: 1. Never <-------> 6. Always

a. Originality/ Novelty	1	2	3	4	5	6
b. Feasibility	1	2	3	4	5	6
c. Strategic alignment to business objectives	1	2	3	4	5	6
d. Fit with capability	1	2	3	4	5	6
e. Market potential/ Value	1	2	3	4	5	6
f. Consumer Benefit	1	2	3	4	5	6
g. Gut feeling	1	2	3	4	5	6
h. Other	1	2	3	4	5	6

C.3. When generating and developing new ideas, with which team is communication important and effective in reducing uncertainty? and Why?

Scale: 1. Never <-------> 6. Very important/effective

	Importance						**Effectiveness**					
a. Product Planning Team	1	2	3	4	5	6	1	2	3	4	5	6
b. Design Team	1	2	3	4	5	6	1	2	3	4	5	6
c. Engineer Team	1	2	3	4	5	6	1	2	3	4	5	6
d. Other (Multidisciplinary)	1	2	3	4	5	6	1	2	3	4	5	6

SECTION D. DATA APPLICATION AND VISUALISATION

D.1. When generating and developing ideas, how would you describe the nature of the use of data, information, and insights?

Scale: 1. Never <-------> 6. Always

a. Formal	1	2	3	4	5	6
b. Informal	1	2	3	4	5	6
c. Structured	1	2	3	4	5	6
d. Unstructured	1	2	3	4	5	6
e. Directly	1	2	3	4	5	6
f. Indirectly	1	2	3	4	5	6

D.2.1. When generating and developing ideas, how much important and effective are following types of data to use? and Why?

Scale: 1. Never <-------> 6. Very important/effective

	Importance						Effectiveness					
a. Market Trends	1	2	3	4	5	6	1	2	3	4	5	6
b. Design Trends	1	2	3	4	5	6	1	2	3	4	5	6
c. Existing Problems	1	2	3	4	5	6	1	2	3	4	5	6
d. Consumer Needs	1	2	3	4	5	6	1	2	3	4	5	6
e. Competitive Products	1	2	3	4	5	6	1	2	3	4	5	6
f. New Technology Opportunities	1	2	3	4	5	6	1	2	3	4	5	6
g. New Social Culture and Behavior	1	2	3	4	5	6	1	2	3	4	5	6
h. Financial Effect	1	2	3	4	5	6	1	2	3	4	5	6
i. Environmental Effect	1	2	3	4	5	6	1	2	3	4	5	6
j. Legal Issue	1	2	3	4	5	6	1	2	3	4	5	6
k. Other (Creative Catalyst)	1	2	3	4	5	6	1	2	3	4	5	6

D.2.2. When generating and developing ideas, which types of data do you frequently use in each phase? and Why?

Scale: 1. Never <-------> 6. Always

	FOCUS						***DIRECTION***						***DEVELOPMENT***					
a. Market Trends	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
b. Design Trends	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
c. Existing Problems	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
d. Consumer Needs	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
e. Competitive Products	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
f. New Technology Opportunities	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
g. New Social Culture and Behavior	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
h. Financial Effect	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
i. Environmental Effect	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
j. Legal Issue	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
k. Other (Creative Catalyst)	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6

D.3.1. When generating and developing ideas, how much important and effective are following data resources to use? and Why?

Scale: 1. Never <-------> 6. Very important/effective

	Importance						**Effectiveness**					
a. Internal Resource Expert	1	2	3	4	5	6	1	2	3	4	5	6
b. External Resource Expert	1	2	3	4	5	6	1	2	3	4	5	6
c. Internal Database Site	1	2	3	4	5	6	1	2	3	4	5	6
d. External Database Site	1	2	3	4	5	6	1	2	3	4	5	6
e. Web Searching Engine Site	1	2	3	4	5	6	1	2	3	4	5	6
f. Journal / Magazine	1	2	3	4	5	6	1	2	3	4	5	6
g. Other (App)	1	2	3	4	5	6	1	2	3	4	5	6

D.3.2. When generating and developing ideas, which types of data resources do you frequently use in each phase? and Why?

Scale: 1. Never <-------> 6. Always

	FOCUS						***DIRECTION***						***DEVELOPMENT***					
a. Internal Resource Expert	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
b. External Resource Expert	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
c. Internal Database Site	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
d. External Database Site	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
e. Web Searching Engine Site	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
f. Journal / Magazine	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
g. Other (App)	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6

D.4.1. When generating and developing ideas, how much important and effective are following data formats to use? and Why?

Scale: 1. Never <-------> 6. Very important/effective

	Importance						**Effectiveness**					
a. Image	1	2	3	4	5	6	1	2	3	4	5	6
b. Text	1	2	3	4	5	6	1	2	3	4	5	6
c. Video	1	2	3	4	5	6	1	2	3	4	5	6
d. Real-Sample	1	2	3	4	5	6	1	2	3	4	5	6
e. Explanation (Speaking)	1	2	3	4	5	6	1	2	3	4	5	6
f. Other	1	2	3	4	5	6	1	2	3	4	5	6

D.4.2. When generating and developing ideas, which types of data formats do you frequently use in each phase? and Why?

Scale: 1. Never <-------> 6. Always

	FOCUS						***DIRECTION***						***DEVELOPMENT***					
a. Image	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
b. Text	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
c. Video	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
d. Real-Sample	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
e. Explanation (Speaking)	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
f. Other	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6

D.5. When generating and developing ideas, how much percentage of internal data (from research teams) do you use? and Why?

0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%